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CALIFORNIA FOREST AND RANGE EXPERIMENT STATION

Berkeley, California

Stephen N. Wyckoff, Director

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In cooperation with the University of California

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Station's Annual

April 1949

ANNUAL REPORT OF THE

CALIFORNIA FOREST AND RANGE EXPERIMENT STATION[1/]

1948

FOREWORD

During 1948, the California Forest and Range Experiment Station has continued on the course laid down at the beginning of the year, completing some projects and making satisfactory headway on others. While not completely met in every case, it is felt that progress toward specified objectives has, on the whole, been satisfactory. The results are given in the reports of the eight divisions in terms of objectives and accomplishments for each.

The program work of the Station is now being conducted in an environment of increasing rate of change, almost, it can be said, of tension regarding the use of the natural resources of the region. The State of California has experienced a 42 percent increase in population in a period of 9 years. This has inevitably brought a sharply rising pressure on the natural resources. Increasing demands for agricultural land, expansion of industry, as well as the larger population, have focussed attention on the availability of water supplies. Large tracts of land previously uncultivated are being prepared for agricultural use which can only be successful with irrigation. In many instances industrial plants are being located in agricultural areas, where they compete with agriculture for ground water. Many communities are growing so rapidly that their domestic water sources are no longer adequate, especially in dry years.

Another effect of population increase is to sharpen attention on the need for more efficient management of some 10 million acres of land now covered by brush and useful primarily as watersheds. There is a growing tendency to try to convert these lands to grazing use, generally by burning off the brush. There are doubtless many areas where fire can be so used, if supplemented by seeding and followed by conservative management. But there is much to be learned before sound methods are established and locations where they can be safely applied are known. And the effects of the practices as developed must be examined in relation to water production. Finally, very little is known about the conditions under which it will pay to convert these brush areas even if it is physically possible. Much factual information is needed, therefore, before best use can be made of this extensive wild-land resource.

1/ Maintained by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California at Berkeley, California.

Increased pressure on the timber resource of California comes now at an unfortunate time. It finds expression in the untimely liquidation of the second-growth stands, generally more accessible than much of the virgin forest. This will obviously result in an unbalance of future age-classes, detrimental to an orderly development of sustained yield operations. On the other hand, sharp demands for lumber and accompanying high prices favor a better degree of utilization of the old-growth stands. Another favorable factor is the expansion of new wood-using outlets -- typified by the present expansion of the plywood industry and the development of pulping and wall-board operations. It is hoped that the latter will provide markets for low-grade materials rather than logs better used for production of the higher grades of lumber.

Many of these tensions are doubtless increased by the high prices which have prevailed during the past few years. On the other hand, a sharp turn in economic conditions might favor the type of "back to the land" movement which has often accompanied unemployment in the past. The effect of future economic changes is difficult to forecast.

While practically every part of the Station's long-time research program will give information useful in the solution of problems such as these, their effect is keenly felt in the conduct of our work. This is as it should be. The Station should be fully aware of new problems as they arise, and as far as possible should give immediate help in their solution. Probably the only way in which this can be done is by more frequent examinations of the Station program, as a whole, and for each division. Difficult decisions will be faced involving choice between different projects and determination of how best to use the resources of the Station to accomplish the greatest good.

FOREST MANAGEMENT RESEARCH
(Duncan Dunning, Chief of Division)

Objectives

1. Ponderosa Pine Conversion Cutting Trials

   a. Extend thinning and pruning experiments in young growth at Blacks Mountain by establishing a second series of test plots in additional age, size, and stand-density classes freed of old growth by the 1947 logging.

   b. Maintain loss, growth, and other records for the experimental forest and permanent test plots.

   c. Process for a progress report, the records from the past 10 years of cutting experiments at Blacks Mountain.

2. Mixed-conifer Management Studies

   a. Complete the first conversion cut of the Stanislaus experiment with special attention to areas ready for restocking with sugar pine in 1948.

   b. Encourage wider application of principles underlying the Stanislaus sugar pine-mixed conifer cutting.

   c. Establish remainder of plots in the yearlong series of hardwood eradication experiments for young-growth mixed conifers at Challenge Experimental Forest.

   d. Analyze 15- to 25-year records for a progress or final report on 14 thinning plots at Feather River, last measured in 1947.

   e. Assemble records for a general report on mixed-conifer management.

3. Mensuration Work

   a. Complete and publish the form-class volume tables for ponderosa pine and sugar pine.

   b. Complete other most urgently needed tables for commercial conifers, particularly white fir, as available funds permit.

   c. Resume preparation of the long-delayed growth report for selection stands.

4. Planting Research

   a. Grow hybrid pine nursery stock for field testing in the fall of 1949 or spring of 1950.

b. Publish the cork oak planting report.

c. Complete the revision of the plantation survey report.

d. Analyze for publication records of planting experiments completed in the last decade.

e. Compile for publication records of natural regeneration studies.

5. Continue assistance to forestry agencies, industries, and individuals

Activities and Accomplishments

Ponderosa Pine Conversion

With logging discontinued temporarily in the Blacks Mountain Experimental Forest, work in conversion of ponderosa pine old growth to regulated stands was limited to improvement of the younger stands, the regeneration phases, and maintaining growth and loss records.

About 57 percent of the experimental forest is well stocked with poor quality advance growth of small size, long retarded by the rather poor site, dense grouping, and competition from mature trees. Thinning experiments in this type prior to 1934 did not result in satisfactory growth, suggesting the necessity for more complete release of reserves. For this reason the overwood was completely removed in logging and a wider range of crop-tree spacing was sought.

Thinning plot installation, begun in 1947, was extended by 8 randomized blocks with crop trees averaging 4 inches in diameter and 15 feet in height. Three degrees of thinning were practiced, besides untreated controls, guided by spacing prevailing in normal yield tables for the site. In the lightest thinning the crop trees of a given diameter were spaced like yield-table stands averaging one inch larger; in the moderate thinning, like normal stands averaging three inches larger; and in the heaviest thinning, like normal stands averaging five inches larger. These plots will be measured for growth after five and ten years and will be rethinned in the tenth year in accordance with their growth performance.

Approximately 2000 crop trees were pruned in four of the Blacks Mountain compartments. A time study was made to determine the influence on costs of diameter of tree, diameter of branch and number of 4-foot trunk sections pruned. A special report is being prepared on this cost phase.

The crop trees ranged in size from 4 to 21 inches, the average diameter being 11 inches. About 74 percent of the trees were pruned to a height of 18½ feet, or four sections. Branches varied in diameter from ¼ inch to 3 inches, averaging ⅜ inch for the lowest 4-foot section and 1¼ inches for the uppermost. The number of branches was fairly constant at 14 to 16 in the two upper sections for trees between 4 and 21 inches. In the lowest section, the number of branches decreased sharply from 20 in the 4-inch trees to 8 on the 21-inch trees.

Time required for pruning ranged from 7 minutes for the smallest trees to about 10 minutes for the largest. Increased time for the larger trees was occasioned mainly by greater branch diameter in the upper sections. Pruning the lowest 4-foot section, corresponding to a butt veneer bolt, required only 0.8 minutes for the largest trees as against 1.2 minutes for the smallest--a result of decreasing number of branches, with little increase in size of branches as tree diameter increased.

An exceptionally good crop of seed was borne in the experimental forest in the fall of 1948, the first of consequence since cutting was begun in 1937. By diverting effort from planting research, this rare opportunity was used to further the natural regeneration phases of the study where preparatory cuttings had been made over a ten-year period. Cone counts were made and seed traps were exposed to measure the crop and its dispersal, the ground was scarified with hand tools or tractor and disc, and the rodents were poisoned on 810 acres. Sound seeds of ponderosa and Jeffrey pines were trapped at rates of 63,000 to the acre in virgin timber; 84,800 to the acre after light sanitation-salvage cutting; 78,000 after moderate Forest Service cutting; and 70,600 after heavy Forest Service cutting. The results of this heavy seed fall and ground preparation will become evident as seedlings appear in the spring of 1949.

Growth measurements were made for the series of methods of cutting plots that have run for five years. The annual loss survey for the experimental forest was made by the cooperating Bureau of Entomology and Plant Quarantine. Insect-caused losses continued at a rather low level as compared with the epidemic peak of 1936, but there has been a fairly consistent increase in mortality since 1944. In the untreated virgin timber losses were 17 bd. ft. to the acre in 1944; 72 in 1945; 64 in 1946; and 76 in 1947. Losses in the stands from which susceptible trees were removed in logging remained relatively very low, being but 10 bd. ft. to the acre in 1947.

Assembling ten-year records for a progress report on the Blacks Mountain project was again delayed by lack of personnel. Tree-class growth records were partially analyzed to guide the selection of crop trees in the stand improvement work.

Mixed-Conifer Management

In the mixed-conifer forests, sugar pine silviculture and management are especially important and have been subjects for research since 1909. Studies of the numerous phases from seed bearing to harvest cutting, conducted separately and consecutively, have developed practices worthy of testing together and concurrently. Such tests were begun in the Stanislaus Experimental Forest in the spring of 1948.

Stand records and surveys were made in the fall of 1947, quarters for a small logging crew were begun in April, logging roads were constructed, logging equipment was brought from Blacks Mountain, and conversion cutting was begun in June 1948. Financial and personal assistance were generously contributed by the Regional Office, Forest Service; the Stanislaus National Forest; the Offices of Blister Rust Control, Forest Insect Investigation, and Forest Pathology; and the Fish and Wildlife Service.

The primary aim of the trial is to establish adequate sugar pine reproduction by group cutting in a good seed year aided by seed bed preparation, slash disposal, rodent control, blister rust control, and supplementary seeding and planting. A second important objective is to reduce to practicable routine certain procedures proposed to make working plans work — more specifically: To simplify and define more clearly the stand condition-classes basic to management; to simplify field routine of sampling for condition-classes and other working-plan data; to test model stand structures set as the goals for regulation; to develop a realistic means of determining the allowable cut that will contribute to mixed old-growth conversion; and to coordinate other management-plan features such as transportation, watershed protection, and young-stand culture.

The first cutting covered 90.5 acres producing a net log scale of 3.6 million board feet. The original stand averaged 85 M bd. ft. to the acre of which 36 percent was sugar pine; 46 percent, fir; 15 percent, incense cedar; and 3 percent, Jeffrey pine. About 35 percent of the area was cut for regeneration of sugar pine in cleared groups producing 75 M bd. ft. to the acre. The remainder produced 29 M bd. ft. to the acre as cut by selection, group release, or selective improvement methods — mainly on portions of the area where sugar pine cannot be maintained in the stand. The average volume reserved was 36 M bd. ft. for all types of cutting. Some 265 M bd. ft. of large sugar pines, retained for their 1948 seed crop, will be removed in 1949.

The outlook for sugar pine restocking has some presently favorable aspects. The cutting design apparently was successful in getting a goodly portion of the excellent seed crop on the right places at the critical time. Inadequate seed at the right time has been an important element in regeneration failures of the past. In the virgin forest, 443 sugar pine cones to the acre were borne. As against this potential maximum, 190 cones to the acre were made available on the special regeneration cuttings as compared with only 62 on conventional cuttings. Some 29,000 good sugar pine seeds fell well-distributed over the prepared openings. Two poisoning operations — one in early summer and one at the time of cone ripening — apparently reduced seed-eating rodents to very low numbers. Logging and slash bunching was completed before the seed fell, leaving the soil favorably exposed. Early rains favored seed coverage, and a subsequent heavy blanket of snow should provide ideal conditioning for seed germination by spring.

On the unfavorable side — white fir showered the soil with 161,000 sound seeds to the acre, a forecast of future cleanings and thinnings that will be necessary to preserve the sugar pine minority. Fortunately, 1948 was an "off" year for cedar. Unfortunately, abundant dormant Ceanothus and Ribes seeds were found in samples of soil by the Office of Blister Rust Control, hence the usual horde of brush seedlings are anticipated on the disturbed areas. These undesirables possibly can be eliminated by selective chemical sprays.

Experience of the year emphasized certain practices for special consideration in these types of cutting. Efficient bunching of heavy slash in the group clearings will require a type of machinery not presently available. Some of the openings are too small to admit burning the heavy material except after seed dispersal. The large burned spots and use of equipment to "chunk up" during burning affect unfavorably a considerable proportion of areas prepared for natural regeneration. Pushing slash to the periphery of openings and leaving it unburned was tried as a hedge against this disadvantage incurring thereby, of course, other disadvantages such as prolonged fire danger.

The difficulty of slash disposal and the problem of seed supply jointly strengthen an inclination towards seeding and planting. Greater reliance on artificial regeneration also would provide more, but not complete flexibility in time of logging. Considerable supplementary seeding of ground beyond the range of seed trees probably always will be necessary as was true in this experiment. Unfortunately, our knowledge of sugar pine planting is not such as to warrant howling optimism in this alternative. More planting will be tried in 1949.

Watershed and soil protection problems are accentuated locally by the complete group clearings. Special attention to drainage and prompt revegetation will be necessary.

Indications from the experiment significant for working plans are that the important condition-classes can be sampled with reasonable accuracy on linear transects of the usual cruise. The information required includes composition, tree-class, and stocking of overwood; composition, size, and stocking of understory. The possible combinations of stand elements requiring separate marking and other treatments are numerous, but relatively few occur frequently. The average condition-class area in this year's experiment proved to be 0.7 acre. Zonation with topography, site, or fire pattern appears weak, hence systematic surveys should suffice in most areas. It appears feasible to derive from the condition-class data the usual stand tables and topography, and the cutting, cultural, and transportation plans. A report is being prepared on the trial of this approach to the working plan.

Numerous foresters — individually and in several groups — visiting the Stanislaus cutting area in 1948, showed a gratifying interest in the project and gave valuable suggestions and criticism. Assistance was given in the woods in administrative tests of some of the procedures on four national forest sale areas, the LaTour State Forest, and in field training of Blister Rust Control men. Objectives and procedures were explained to two groups of the Society of American Foresters and a University of California student seminar. An article was prepared for the Agricultural Yearbook jointly with the Division of Timber Management, Region 5.

Surveys and plans have been completed for cutting about 4 million bd. ft. from 108 acres in 1949. Another fair crop of sugar pine seed, now developing, will enable completing the two-year cutting program for this site and type.

At Challenge Experimental Forest, hardwood brush control by cutting and chemicals was continued through a complete cycle of seasons. Season of cutting had no appreciable effect on sprouting. All untreated stumps sprouted. A one percent water solution of 2,4-D ester — 1/2 to 1 pint per stump — prevented sprouting in 40 percent of the tan oak stumps and 68 percent of the madrone stumps.

The progress report on the older thinning experiments at Feather River was deferred.

Mensuration

The volume and taper tables by form class completed last year for ponderosa pine were found suited to use for white fir and Douglas-fir as well, according to results of analysis of measurements of the two latter species. Similar tables prepared for sugar pine were found applicable to red fir.

These tables are made for a fixed reference point of 10 inches inside bark in the top for simplicity in height determination, but they also enable good estimates of utilized volume according to national forest timber sale standards. They can be adapted readily to any other standard of utilization for local use. Low aggregate and single tree deviations promise accurate estimates for small volumes of timber as are required in sales by standing tree measurements. Results to be expected are indicated in the following tabulation.

Species	Aggregate difference between table and scale - percent	Standard deviation - percent	Trees compared
Ponderosa pine	0.46+	5.70	500
White fir	0.53-	4.25	331
Douglas-fir	1.27+	5.26	383
Sugar pine	0.08-	6.60	551
Red fir	0.17+	5.70	349

Many requests for these tables by practicing foresters could not be satisfied because funds were not available for publication. The original tables are available for use in the local Forest Survey.

Revision of the growth-predicting charts for selection stands was again deferred because of reduction in personnel. Original charts prepared in 1933 were duplicated photographically to meet temporarily the needs of several industrial and public foresters.

Regeneration

Planting and natural regeneration research was directed toward preventing loss of established projects, salvaging experimental stock, taking advantage of the rare opportunity afforded by the 1948 seed crop, and compiling records of completed experiments insofar as one man's capacity can be stretched.

Seedlings of six of the most promising hybrids developed at the Genetics Institute were grown with regularly planted species at Feather River, Stanislaus, and Placerville. The small supplies of seeds germinated well and normal development occurred in the seedbeds so that the seedlings can be transplanted in the spring of 1949. These trees are being raised for field testing in 1950 as 1-1 stock in the normal range of natural timber species.

The cork oak planting report was completed and has been accepted for publication by the Journal of Forestry.

The report on the survey of administrative plantations was discussed with the Division of Timber Management, Region 5, and has been revised, mimeographed, and sent to the national forests for review and criticism.

The stock-grade study at Feather River was continued by outplanting maturing transplants in a test of the efficiency to be gained by using tree diameter in conjunction with height as a grading criterion. Earlier tests had indicated that the thicker transplants, even when moderately short, may survive and grow well enough to justify utilizing higher proportions of nursery output.

Seed-bed sowings were made at Feather River and Stanislaus Nurseries to grow small quantities of stock for experimentation and supplementary planting in conjunction with the ponderosa pine and sugar pine conversion cutting projects.

Some 70 pounds of sugar pine seed and small quantities of other species were collected from the 1948 crop for current and future studies.

To determine the most favorable period for collecting sugar pine seed, a series of weekly cone collections was made, cone densities were measured, and seed was extracted and stratified preparatory to germination tests. Density of the cones dropped from 0.93 in the first week of September to 0.78 in the first week of October when the first cones began to open.

Seed-bearing records from numerous trees in 10 to 12 locations have been made annually since 1933. These were repeated for the good crop of 1948 and, as previously mentioned, additional counts and seed trap records were made as part of the Blacks Mountain and Stanislaus cutting experiments. These crop records have now covered enough time to provide valuable information on periodicity, effects of cutting, characteristics of good seed trees and pattern of dispersal. A summary is being prepared for special release which will contribute also to the more general report on mixed-conifer management.

Direct seeding experiments with sugar pine were continued in conjunction with the Stanislaus cutting experiment by sowing in proper design 400 screened and 400 unscreened seed spots. Besides needed information on direct seeding, this installation will provide information as to the effectiveness of attempted rodent control.

Increasing the success of natural seeding by seed coverage was attempted on the sugar pine cutting area by establishing for comparison raked and undisturbed plots after seed had fallen.

A manuscript summarizing progress of natural regeneration in the Stanislaus area was completed in form for review. Over a period of 20 years after logging, pine seedlings became established at a rate of only 70 to the acre, constituting but 5 percent of the reproduction. Only 13 percent of the dominant seedlings - the potential crop trees - are pines. Brush-covered ground increased from 17 percent, immediately after logging, to 56 percent 20 years later. The common belief - or hope - that seed trees, fire protection, and time will insure natural restocking is not supported by these records. Several carefully timed, mutually supporting measures to establish reproduction immediately after logging seem necessary. Such measures are being tried in the Blacks Mountain and Stanislaus experiments.

An encouraging boost for natural and artificial regeneration research was given by the assignment of a biologist, Dr. William Jamison, to rodent investigations by the University of California in September. Dr. Jamison's biology work is under the direction of Dr. Tracy I. Storer of the Zoology Division, Davis Campus. Studies of rodent populations and winter behavior are being conducted from Feather River Branch Experiment Station. Observations will be undertaken this spring in the sugar pine forests in connection with the 1949 Stanislaus cutting experiment. Dr. Jamison's work is expected to extend over several years and is designed to acquire adequate knowledge of the animals involved, leading ultimately to effective control.

Aid to practicing foresters was directed mainly toward application of mixed-conifer management findings, as mentioned previously. Considerable material compiled for the general report on mixed-stand management was put in shape for field use in a training camp for State foresters planned for the spring of 1949. Planting experience was drawn upon in giving field advice on fir planting on a Sierran tract newly purchased by a large Christmas tree producer. Rapidly developing industry in the redwood region resulted in several requests for growth records and cutting advice which were given insofar as time permitted.

Plans for 1949

The aim of the Division in 1949 will be to complete the most urgently needed field application tests, reduce to a minimum field examinations of many long-term studies, and curtail nursery and branch station maintenance so that remaining staff men can concentrate on many long deferred publications in 1950.

1. Ponderosa Pine Management

   a. Complete the Reinventory of the Blacks Mountain Experimental Forest so that a 12-year progress report can be made.

   b. Continue analysis of growth and stand structure change for the above progress report.

2. Mixed-conifer Management

   a. Complete conversion cutting tests in sugar pine-fir at Stanislaus, logging about 4 MM b.m. on 108 acres.

   b. Examine the 1948 Stanislaus cutting areas for results of natural reproduction, seeding, and rodent control. Remove 256 M b.m. of seed trees from 1948 area.

3. Mensuration

   a. Publish form-class volume tables, if funds available.

   b. Continue analysis of mixed stand growth data for publication.

4. Regeneration

   a. Transplant hybrid nursery stock. Prepare test fields for outplanting, if possible.

   b. Transplant and outplant present nursery stock for grading tests and reexamine established plantations at Feather River.

   c. Complete germination tests for cone ripening study.

   d. Continue analysis of reproduction, seed crop and site-factor records for publication.

   e. Continue cooperation with University of California in rodent-tree-regeneration studies.

5. Continue supplying materials and advice to practicing foresters on pine and mixed-conifer management.

FOREST GENETICS

(W.P.Stockwell, Chief of Division)

Objectives

1. Continue study of methods for mass production of hybrid seeds, particularly to search for consistent seed bearing trees to be used as the seed parent in crossing work.

2. Emphasize experimental crossings rather than mass production crosses, with particular attention to the southern pines.

3. Continue phylogenetic crossings during early part of season before the timber pines begin to shed pollen. Include in addition to the closed cone pines the species P. Torreyana, P. canariensis and P. longifolia.

4. Examine the oleoresins of P. parviflora and P. cembra and other species that may become available.

5. Continue the clonal studies of the hybrid P. attenuradiata second generation population, including other hybrids that become available in quantity.

6. Complete old projects and undertake new work as indicated by results and available funds.

Activities and Accomplishments

Mass Production Studies

Approximately 20,000 seeds from the 1946 pollinations were transferred to the Regional Office and were planted in the McCloud Nursery. Most of these were of the Jeffrey-Coulter hybrid.

From the 1947 pollinations, approximately 43,000 seeds were collected, 11,000 being from the Jeffrey-Coulter cross, the remainder being distributed among seven other crosses.

In 1948, a program of 1,000 pollination bags was carried out as follows:

Pinus echinata x P. taeda	247 bags
Pinus monticola x P. strobus	212 bags
Pinus Murrayana x P. Banksiana	271 bags
Pinus ponderosa x P. apacheca (and reciprocal)	126 bags
Pinus ponderosa x P. arizonica	100 bags
Pinus ponderosa x P. ponderosa var. scopulorum	49 bags
	1005 bags

Yield of seed is difficult to predict. For instance in 1947 one hundred bags used to produce the Jeffrey-Coulter hybrid yielded 11,000 seeds, while 250 bags yielded only 711 seeds of the hybrid monticola x excelsa. In general the crosses involving ponderosa pine and Jeffrey pine have been more prolific than other species groups, having averaged 45 seeds per bag in the rather unfavorable year 1947. Although costs of hybrid seed will doubtless be reduced as methods are improved, they will probably remain high as compared with field-run forest collected seeds. This situation has spurred the genetics group to cast about for cheaper means of producing usable hybrid seed. Several plans will be tried as soon as possible.

1. The first plan is to interplant clones to produce seed from which first generation hybrids will be grown. Clones are the vegetative offspring of a single tree, produced by cuttings or by grafting scions of the tree on suitable rootstocks. Most of the pines do not have a high degree of self fertility, and members of a clone, being parts of a single individual, will not interpollinate. When clones from two different parents are planted together the offspring will be mostly the product of cross fertilization between the clones. Further, as self-fertilized pines are usually much weaker and smaller than cross-fertilized seedlings, it will be easy to separate them in the seedbed.

2. In the second plan blocks of first generation hybrid trees would be planted. Seed collected from these trees would produce second generation hybrid seedlings. Second generation pine hybrids, so far as known, are variable as would be expected, but among the population enough outstanding hybrids occur to justify their use. The culling of nursery stock will doubtless be higher than in the first plan but no more difficult to carry out.

3. The third general method requires the planting of individual trees at remote intervals in a natural stand. These single trees may be of a species that will cross with trees of the natural stand or they may be first or second generation hybrids that will cross with the native trees to give backcrosses or more complex hybrids. Seed from these trees would produce usable hybrid seedlings with some self fertilized offspring.

Several variations of these basic plans are possible. Results at the Institute indicate that these methods have promise. Hand pollination would be unnecessary, and seed collection should cost no more than from other forest trees. Ten years after planting such seed farms should begin to yield worthwhile quantities of hybrid seeds. It is important to start such plantations as soon as funds for the work can be secured.

This year the search for dependable seed-parent trees was curtailed to conserve travel funds. However a number of trees were marked when other necessary travel provided the opportunity.

Experimental Crossings

In the experimental crossings, particular attention was given those members of the southern pine group of which fruiting material was available. A total of 99 different interspecific crossings were made, eight of which involved southern pines. More tests with the southern pines will be made this spring and later, as the trees in the arboretum develop. These crosses of only a few bags each will yield, if successful, seed enough for a few dozen seedlings each. Those crosses that seem noteworthy will be repeated later.

Water shortage necessitated reducing the size of the nursery planting in 1948, nevertheless some planting was done. The new hybrids planted were:

Pinus echinata x P. glabra (all died early).
Pinus monticola x P. ayacahuite
Pinus monticola x (P. peuce x P. strobus) pollen from Denmark
Pinus ponderosa x P. Montezumae

Mr. John Miller of the Forest Insect Laboratory staff has been carrying on tests of insect resistance of various species and hybrids at the Institute. His demonstration that the Jeffrey-Coulter hybrid is resistant to attack from the pine reproduction weevil has led to the selection of this hybrid for large-scale field tests in California. As more planting becomes necessary in the west resistance to insect attack will become more important, particularly resistance to attack during the early life of the tree. These are among the first studies of insect resistance of juvenile forest trees. To continue this work special plantings were made at Placerville with the following hybrids and their parents:

Pinus ponderosa x P. apacheca
Pinus ponderosa x P. arizonica
Pinus ponderosa x (P. Jeffreyi x P. Coulteri)

Another planting for the same purpose was made of ten national species and one hybrid.

Pinus attenuata
Pinus attenuradiata (a hybrid)
Pinus Banksiana
Pinus Lambertiana
Pinus muricata
Pinus monticola
Pinus Murrayana
Pinus ponderosa
Pinus ponderosa var. scopulorum
Pinus radiata
Pinus Sabiniana

Other test plantings of the Jeffrey-Coulter cross and its parent species were made in brushfields of the Lassen National Forest, where the pine reproduction weevil has been a serious pest. These plantings were made by the Forest Insect Laboratory with the help of the Forest and the Institute.

Phylogenetic Studies

The phylogenetic crossings were continued as time permitted but seed produced in this work was not sown in 1948. Of the 99 crossing attempts made, 34 were done primarily to study relationships. While these crossings are done primarily to study relationships and the crossing behavior of species, it is not unlikely that some of the hybrids may be of value for other purposes. It is interesting that recent Swedish publications have emphasized elite tree selection, which is one of the phylogenetic problems included in these studies.

Examination of Oleoresins

The oleoresins of Pinus parviflora and P. cembra were examined. In addition a preliminary investigation of the turpenes of P. contorta and P. Bolanderi was made. Other samples of oleoresin acquired but on which work is not yet complete are from:

Pinus flexilis
Pinus aristata
Pinus monticola (received from Northern Rocky Mountain Experiment Station)
Pinus echinata (Southeastern Forest Experiment Station)

The chemical nature of the oleoresins is proving to be of increasing value in determining the relationships of the pines, on which the crossing plans are based. For instance, the foxtail pine of the Siskiyou Mountains and that of the Mt. Whitney region are essentially identical morphologically, yet they are distinguishable by laboratory tests. This indicates that their breeding behavior may be sufficiently different to require testing each form in crosses where this species is concerned.

The results to date of this work were published (see Mirov under publications).

Clonal Studies

It would be of great value if all forest trees could be propagated by cuttings as are poplars and most named fruit varieties. This would enable the forester to reproduce in great quantity any particularly desirable tree that he discovered. This type of plant production, called clonal production, is very important in the history of plant-improvement work. It has been demonstrated by Snow at the Northeastern Station and Mirov and Duffield at this station that individual pine trees vary in their capacity to strike root from cuttings. Duffield has been testing the rooting capacity of the segregates, or individual members, of a second generation hybrid population of Pinus attenuradiata for rooting capacity. Clones of a number of segregates have been tested. It is hoped that this work may lead to the segregation of

certain hybrid forms that may be reproduced by vegetative means. This year in addition to the hybrid attenuradiata, the following species and hybrids were added:

Pinus Banksiana
Pinus muricata
Pinus radiata
Pinus Murrayana x P. Banksiana
Pinus monticola x P. strobus
Pinus muricata x P. radiata
Pinus Jeffreyi x (P. Jeffreyi x P. Coulteri)

This work indicates that great differences in ability to root exist not only between species but between individuals of a single species or hybrid.

Other Activities

Some improvements in the physical plant were possible this year. Constant temperature rooms were completed, the labor being done by the Institute staff while lumber was provided by Supervisor Smith of the Eldorado National Forest. The humidity controls in the greenhouse were redesigned and overhauled by Liddicoet to provide better conditions for the rooting of cuttings. The nursery area was fenced to protect it from rabbits and stray livestock.

Plans for 1949

1. Plant in the nursery, seed from 1948 collections and those seed of 1947 collections held over because of lack of water for nursery production.

2. Concentrate experimental crossing work on the southern pines.

3. Continue phylogenetic crossings as time permits.

4. Attempt production of test seed of the Coulter-Jeffrey hybrid — the goal being enough seed to produce 100,000 trees of this cross if funds for labor and material become available.

5. Complete old projects and undertake new work as indicated by results and available funds.

FOREST FIRE RESEARCH
(C. C. Buck, Chief of Division)

Objectives

The following jobs were planned for 1948:

1. Fire Damage Appraisal

Supervise reproduction of damage tables, prepare instructions for use and write a description of the methods used in their development.

2. Chemical Control of Vegetation

Inspect 1947 plot treatments with 2,4-D and complete Laboratory-Station manuscript on recommended uses of chemicals for vegetation control.

3. Ignition Time and Temperature Study

Secure technical review of analysis and conclusions and prepare manuscript for publication.

4. Forest Fire Behavior and Control

Resume long-term research program as fast as men and facilities become available, concentrating current effort on analysis of data on hand and continuing the study of water use with Equipment Development Center.

Activities and Accomplishments

1. Fire Damage Appraisal

The fire damage tables, maps, and overlays necessary for use in making individual fire-damage appraisals were transmitted to the four southern California forests covered by the study. Reproduction of small-scale maps for inclusion with the tables to be sent to cooperating and other interested agencies and individuals was nearly completed by the end of the year.

A summary of average fire damage from increased run-off and erosion by individual drainage units was prepared and reproduced for distribution. These tables were derived from the more detailed tables above and are intended primarily for use in establishing protection objectives and in other phases of protection planning work.

The four national forests covered by the study are already applying the results in their fire-control planning activities. By dividing the total range of expected watershed damages per acre into relative classes of potential damage it has been possible to establish zones of relative potential damage for each forest. Comparison of these zones with the intensity of fire protection currently afforded

them indicates that from a watershed standpoint some areas are under-protected and some are over-protected. Even though other values than potential watershed damage must be considered in evaluating protection needs, it is nevertheless evident from the study that redistribution of available protection effort is called for in numerous instances.

The results are also being applied in the development of fire programs in current Department of Agriculture surveys for flood control.

An office report describing the detailed procedures used in developing the fire-damage tables was completed, and a manuscript presenting the hydrologic data used in the damage study was brought to the final draft stage.

2. Chemical Control of Vegetation

Final inspections were made on brush-control plots treated with ammonium sulfamate and 2,4-D during the previous three years. Results were analyzed and such conclusions drawn as were applicable to brush-control practice. There is not yet a satisfactory answer to the chemical brush-control problem. The possiblity of killing many shrub species has been shown. With the exception of a few easy-to-kill species, however, chemical control methods have not been developed that will assure uniform success without excessive cost. Much additional work remains to be done to develop application techniques for the chemicals now available and to test new formulations as they are developed. Many agencies and individuals are currently working on the problem in California. All feel the urgent need for coordination and pooling of effort to avoid duplication and waste.

A beginning was made on the job of bringing up to date information collected three years ago as a basis for a proposed publication on recommended uses of chemicals in forest-vegetation control. Initial work has also been started on the manuscript. Owing to the paucity of data on this specific subject the section on control of shrubs will still not be as complete as we should like to have it, but considerable information of general usefulness can be included.

3. Ignition Time and Temperature Study

Preliminary draft of a manuscript entitled "The Heating and Ignition of Small Wood Cylinders" was prepared and a technical review was secured. Additional data as recommended by the reviewers was obtained and will be incorporated, following its analysis, in a manuscript to be submitted for publication.

Although this initial study was confined to one species of wood, the results have established the effects which size, moisture content, initial temperature and rate of heating have on time of ignition. Since a fire will spread fastest in the direction where ignition time is least, the study provides fundamental information useful in predicting critical sectors of rapid spread on a fire perimeter.

The temperature measurements made in the study show that when wood is heated its surface temperature is near 650° F. when flame appears. The heating, however, must be done by a source having a temperature greater than 800° F. Otherwise the wood is reduced to charcoal without flame appearance. Once reduced to charcoal, however, glowing in an atmosphere having a temperature as low as 450° F. was noted. This knowledge of temperatures associated with flame appearance and glowing has proven of much help in the study of use of water and chemicals for fire suppression, particularly as it related to the cooling necessary to prevent rekindling.

4. Forest Fire Behavior and Control

During the first half of the year the Station collaborated with Arcadia Fire Control Equipment Development Center in planning and supervising fundamental studies on wetting agents for fire suppression at the University of California at Los Angeles. Complete responsibility for both direction of and active participation in this study was taken over by the Station in July. Laboratory phases of the study have since gone forward at both Berkeley and Los Angeles. Excellent progress has been made at both places on fundamental aspects of water and combustion. Preliminary laboratory model fire tests have indicated that some wetting agents are much superior to water for flame suppression under carefully controlled laboratory conditions. Large superiority factors over plain water have thus far shown up only when comparisons are made with highly efficient applications. Field tests of the use of wet water in suppression were also carried out to determine whether it has any readily apparent superiority over water, under typical field conditions. Fifty tests in a number of forest fuels, indicated a saving of about 15 percent in volume of water needed for the conditions under which the tests were made. Further tests are needed, however, since greater savings might be made with different application techniques than those employed in this series.

Past field studies have resulted in accumulation of considerable data on wind, temperature, humidity and fuel moisture on and near the ground surface. Analyses of these data to define some of the microclimatic relationships necessary for proper measurement and interpretation of weather and fuel elements for fire-control purposes were started during the year. None is yet at the reporting stage.

Plans for 1949

1. Fire Damage Appraisal

Adapt the principles developed in the southern California study for use in appraising fire damage from increased run-off and erosion on all the remaining California national forests. The study program for the current year will be confined to the development of an appropriate method. Necessary steps are: (1) to inventory available data on which to base northern California estimates, (2) to analyze methods used in the southern study to determine which are appropriate for application in the north and which need modification or rejection, and (3) to sort out and piece together available information into a system that will yield usable estimates of watershed fire damage on the northern forests.

This study is expected to develop one of two possible methods for appraising fire damage to northern California watersheds. The first might be a prescription that individual appraisers can apply in the field as needed. The second would be of a project nature resulting in preparation of damage tables comparable to those developed in the southern study.

2. Chemical Control of Vegetation

Maintain contact with work done by other agencies that has application to problems of controlling forest vegetation. Promote pilot testing of new developments in this field, conducting such small-scale field tests of promising chemicals as opportunity permits. Complete the manuscript on present recommended practices for chemical control of forest vegetation.

3. Water and Chemicals for Fire Suppression

Continue the present study of wetting agents for fire suppression in cooperation with Arcadia Fire Control Equipment Development Center. It is proposed that laboratory and analytical phases of the study previously carried out under contract at University of California at Los Angeles be taken over by the Station in 1949. Both laboratory and field testing will be carried forward during the year. The current specific objectives are to determine the desirable specifications for an effective wetting agent for purposes of forest-fire control.and define its specific uses for effective and economical fire-fighting practice.

4. Fire Danger Rating

Analyze past fire-danger records in relation to fire business on the individual national forests to accomplish two things: more firmly establish the relationship between current fire-danger trends and fire occurrence and behavior on the individual forests; and provide information necessary for further development of operational tactics aimed at more efficient protection under fluctuating levels of fire danger.

5. Large Fire Organization Management

Reanalyze large fire organization management practices to establish sound principles of organization control, use of technical staff, functionalization of organization elements and like problems.

FOREST ECONOMICS
(A. E. Wieslander, Chief of Division)

Objectives

1. Forest Survey

Inventory

a. Complete the classification of age and density of timber stands from aerial photographs for a gross area of 7.3 million acres and transfer these classifications to base maps.

b. Complete volume sampling for 5.3 million acres of commercial forest land.

c. Complete the area and volume compilation by punch card for 11.0 million acres of forest land, including three complete counties and portions of five others.

d. Compile sample tree data collected through 1947 to localize volume tables and prepare curves of volume over diameter by species, site, and tree class groups.

e. Complete volume tables and bark thickness curves for most important hardwoods, and provide assistance to Forest Management Research in deriving factors and volume tables needed primarily for Survey use.

f. Complete field sampling and compile the estimate of mortality in the Coast Range pine and Douglas-fir subregions and of fire mortality in the entire State.

g. Prepare plan for cruising cut-over areas in the redwood subregion adjusting existing old-growth cruises to Survey standards.

h. Seek a method of estimating the number of owners by private ownership types and size classes, through the line sampling method.

i. Study sampling variance for ways of reducing costs.

j. In cooperation with Dr. Kimmey of the Bureau of Plant Industry work out defect factors for the principal species, based on data now on hand.

k. Release county statistical reports and subregion analytical reports as they are completed.

Drain and Requirements

l. Convert the commodity production statistics in unit measure to equivalents in log scale, International 1/4-inch rule.

m. Prepare a detailed working plan for the evaluation of woods waste as a factor in total drain and conduct the necessary studies to obtain the desired information.

n. Complete a detailed office report describing methods and findings of the study of wood used for residential construction and prepare suitable portions of the report for publication.

o. Prepare estimates of container lumber requirements.

p. Prepare estimates of lumber requirements in California for other manufacturing uses, based on national requirements studies, and information on industrial activity in the State obtained from secondary sources.

2. Forest Economics Research

Continue the study of economic aspects of sugar pine management and blister rust control, emphasizing analysis of the effect of type, site, age class, and stocking variations on the economic practicability of sugar pine management, and on the development of effective methods for classifying sugar pine areas with respect to their economic suitability for permanent sugar pine management.

3. Other Activities

a. Continue State Division of Forestry cooperation, including:

(1) Intensify the classification of timber cropland, range, and watershed land from aerial photographs for 5.5 million acres included under (a) of Inventory plans for 1948.

(2) Complete the field work for type and site mapping and soils classification of 2.2 million acres.

(3) Prepare for distribution maps (2 sheets) of 40 quadrangle units, or 1.4 million acres. In the main the first sheet of the set portrays the classifications obtained from the photos and the second the information that is added in the field.

(4) Compile the acreages of the various classifications by ownership, for 3/4 million acres.

(5) Complete work on aerial photography and base-map construction.

b. Complete the analysis and preparation of an article on the relative merits of panchromatic and infrared-minus blue aerial photography for forestry purposes in California in cooperation with University of California.

c. Keep cooperative ownership study with Bureau of Agricultural Economics abreast of field and office work in the inventory, and publish by the multilith process the manuscript for the pilot ownership study in northern Mendocino County.

Activities and Accomplishments

Considerable progress in all major Division programs was made during 1948, even though planned objectives in certain respects were not fully realized because of manpower losses and other unavoidable difficulties.

The work conducted in cooperation with State Division of Forestry was particularly encouraging for a new job still very much in the development stage. Since the classification of soils on upland areas has been largely untried in practice, it was inevitable that many problems would be encountered in identifying existing soils and in recognizing new soils which would call for close study and correlation by consulting soils scientists. In fact, because the success of the project largely depends upon accurate field identification and in-place mapping, it was considered advisable to proceed rather cautiously in the early stages by concentrating more on the development of techniques and procedures and training so that acceptable results would be achieved.

Because of other pressing jobs in their departments, University and U. S. Division of Soils consultants were unable to allot as much of their time to the project as was needed. Better progress with less wasted effort would have resulted, had it been possible for these specialists to devote more time to advance field reconnaissance and checking of the initial field mapping as it progressed.

Specifically, the more important accomplishments were:

1. Forest Survey

Inventory

a. Photo classification was completed for about 109 7-1/2 minute quadrangles, a gross area of 4.4 million acres. Transfer of classifications to base maps was completed for 86 quadrangles, a gross area of 3.5 million acres. (Cumulative progress to end of period represents 51 percent of classification job completed, and 45 percent of transfer job completed.)

b. Volume and growth sampling were completed for 4.1 million acres of commercial forest land. This is represented by 285 field locations or 855 plots of 1/5 acre each in stocked areas, and by 6 field locations or 36 chains of transect in unstocked areas. Cumulative progress to date represents 50 percent of the sampling job completed.

c. Punch card compilations of area and volume, slowed by late delivery of card-tabulating machines, were completed for an average of 5.5 million acres of forest land. Most of the compilation work was done for the Coast Range pine subregion. No one county was completed because of need for correction of certain maps and cards, but eight different counties can be considered partially completed. Completed work in the different operations was:

Area measurement (222 quads)	27.3 percent	- 8.9 MM ac.
Area compilation	6.7 "	- 2.2 " "
Volume compilation	25.4 "	- 8.3 " "
Average	16.8 "	5.5 " "

d. Sample tree data collected through 1947 and 1948 (15 percent of total job) were compiled, providing averages of height and form class needed for localizing form class volume tables to site and tree class groups. This work was done using punch card tabulating equipment.

e. The volume tables for most important hardwoods have been completed. For conifers, the factors needed for conversion of volumes from Scribner Dec. C to International 1/4-inch rule, and from board feet to cubic feet have been completed, but no volume tables have yet been prepared. Bark thickness curves for most important hardwoods have been completed and also for all conifers except old growth redwood.

f. Field sampling of mortality in the Coast Range pine and Douglas-fir subregions was completed, and field sampling of fire mortality in the entire State was completed. Compilation of results was begun.

g. A plan for sampling cut-over and lower density virgin areas in the redwood region was completed and included in "Revisions and Additions to Manual of Instructions, Inventory Phase, Forest Survey - California." Negotiations were conducted toward obtaining use of cruise data for higher density virgin redwood areas, but these were not available by the end of the calendar year.

A determination was made of changes in age-density classes due to fire or logging since the photos were taken, in order that area figures could be brought up to date. This was done in the field along transect lines that coincided with the area line transects spaced 2 miles apart on the maps.

h. A method of estimating ownership data by line sampling was prepared, and is to be published early in 1949 in Land Economics under the title of "A New Approach to Forest Ownership Surveys" by A. A. Hasel and A. Poli.

i. Sampling variance was studied for ways of reducing costs. On the basis of the results it was decided that the present system of sampling by 2-man crews is most efficient in the Coast Range pine and redwood—Douglas-fir subregions, but that probably it will be more economical to shift to 1-man crews in the Eastside Sierra subregion.

j. Due to Kimmey's (BPI) assignment to other projects, the work on defect factors was not carried to completion, but substantial progress was made. Kimmey collected additional field data on hardwoods and he has prepared factors to apply to our taper curves.

k. No county statistical or subregion analytical reports have been released to date, although area statistics for Siskiyou and Trinity Counties can be processed at any time.

Drain and Requirements

l. The results of the field survey of commodity production conducted in 1947 for the year 1946 were compiled, summarized, and analyzed and a report issued as Forest Survey Release No. 6.

m. Detailed plans for woods waste studies were developed. In addition, data from the woods waste plots taken in connection with the timber reappraisal for the pine region in 1944 were analyzed and brought into conformance with survey standards. Plot data were summarized by operation, by type of ownership, by subregion, and by size of owner. Aside from the reappraisal data about 75 new sample plots were measured in the field at 8 redwood operations and 9 operations in the Douglas-fir region to provide reliable estimates of volume removed in logging and the amount of unutilized material resulting from logging. These randomly selected plots were divided equally between volume and waste plots to provide the ratio of waste to volume removed. Five large redwood operations remain to be sampled before the data can be analyzed and a report of the findings prepared for release.

n. A study of the "Average Wood Requirements for Residential Structures in California" was completed. The many factors causing differences in wood use ratios were analyzed and the significant differences in dwelling size between different geographic and community-size segments determined. The study showed that the average lumber requirement per dwelling unit throughout California was 8.70 M board feet, of which 74 percent was rough, or construction lumber, 23 percent was finish lumber, and 3 percent was wood

siding. These and other significant disclosures were made in reports prepared by Vaux and May for publication in two magazines: the California Lumber Merchant and the Journal of Forestry.

Work on other requirement studies was withheld until policy decisions are made which will correlate regional responsibilities with those of the Washington Office.

2. Forest Economics Research

The study of economic aspects of sugar pine management and blister rust control was continued throughout the year. However, the Division's part in this study was somewhat altered by Vaux's resignation in July. Since that date the Division has been cooperating informally in the work by preparing the age, density, site, and type maps needed and doing other essential service jobs.

The preliminary report summarizing available data on sugar pine markets and supplies, prices of sugar pine stumpage, and potential costs of growing sugar pine under the conditions imposed by blister rust hazard was reviewed by the various Federal and State agencies concerned and by the State Advisory Committee. A revision and condensation of this report was published as Forest Research Note No. 58.

More intensive analysis of the problem, particularly in relation to cut-over areas, was begun on a selected unit in southern El Dorado County. Age, density, site, and type maps were compiled. Using records of the Office of Blister Rust Control and sample plot data provided by the Division of Timber Management, Region 5, analysis of the relations between timber stand conditions, as shown by the map, and sugar pine growth potential and costs of ribes control was begun. This work was only partly completed at the end of the year.

3. Other Activities

a. In its cooperation with the State Division of Forestry, and with State funds, the Division:

(1) Completed the work required to obtain new aerial photography for about 10,650 square miles.

(2) Advised the State in its program of base map construction for survey purposes.

(3) Intensified the survey classification of age and density of timber stands to a 10-acre minimum (91 7-1/2 minute quadrangles) on 3.3 million acres outside the national forests, and classified vegetation types according to species composition and predominant underlying soil and site-productivity class for 0.9 million acres, or 26 quadrangle units.

(4) Prepared 26 Timber Stand maps, and 5 Vegetation and soil maps along with a 15-page illustrated folder containing legend sheets and detailed descriptions of the map information, for release to the public.

(5) In cooperation with the Bureau of Plant Industry, Division of Soils, collaborated in describing five new soil series, and in revising the description of four established series. Eight additional new series have been mapped but final acceptance is withheld pending description and correlation by BPI.

(6) Collected plant specimens of dominant species occurring on each mapped quadrangle for verification by consulting botanist. Prepared field identification keys for certain species as an aid to field mappers and for species listed on the individual maps, scheduled for early release, for the benefit and assistance of those wishing to identify the plants in the course of field contact.

b. The results of the study made by Jensen, and R. N. Colwell of the University of California School of Forestry staff to test the relative merits of panchromatic and infrared minus-blue photography for forestry uses under California conditions will appear in an article to be published in the June 1949 issue of Photogrammetric Engineering. Significant conclusions were (1) panchromatic minus-blue photography yields much more information for the objectives of the California Forest Survey than is obtainable from infrared minus-blue photography, (2) this holds for both the 1:15,000 and 1:20,000 photo scales, and (3) where different film-filter combinations are justified, considerably more information can be obtained from a study of both panchromatic and infrared photography than from either alone.

c. The cooperative ownership study with the Bureau of Agricultural Economics, initiated early in 1947, has kept abreast of the survey program. The results of a pilot study appeared in Forest Survey Release No. 5. Jobs done during 1948 consisted of (1) obtaining the ownership boundaries and names and addresses of owners from County Assessors in 8 counties (equivalent to 6.3 million acres), (2) obtaining the acreages, assessed values, and land use and tenure information for each particular ownership in 5 counties (equivalent to 11.8 million acres), and (3) placing the accumulated information collected for Siskiyou County on punch cards for compilation purposes.

A manuscript, "Forms of Forest Tenure," was prepared for publication by Mr. Poli. This is a project statement for the Society of American Foresters and the Charles Lathrop Pack Forestry Foundation, and is to be included in a proposed new bulletin dealing with research in the economics of forestry.

d. In cooperation with the Northern Rocky Mountain Forest and Range Experiment Station, some consideration was given to the preparation of a Forest Survey Plan for the remaining Rocky Mountain territory, Regions 2, 3, and 4. Dickerman of R-1 and Wieslander traveled in the three regions to familiarize themselves with conditions and to discuss the matter with Station and Regional Office representatives. Vegetation maps were compiled from existing information, aerial photo coverage was analyzed, other pertinent data were collected, and two alternative survey designs were proposed for consideration.

e. An index map of California showing the present coverage with acceptable aerial photographs has been prepared in cooperation with the Regional Office. It will be printed by the Regional Office for general distribution. Area coverage segregations will identify the agency that holds the negatives and will indicate the project symbol, and year of photography. Source information such as this will satisfy a demand that has existed more or less since the first flying project was undertaken in California.

Plans for 1949

It is anticipated that personnel difficulties will be as great a factor to contend with during the coming year as it has been in the past. Signs of this are already apparent. Accordingly, it will be noted that less optimism is expressed in the plans for next year.

1. Forest Survey

Inventory

a. Complete classification of age and density of timber stands from aerial photos for 75 quadrangles or a gross area of 3.0 MM acres and transfer these classifications to base maps.

b. Complete volume sampling for 6.0 million acres of commercial forest land.

c. Complete area and volume compilation as follows:

Area measurement	127 quads	=	15.7	percent	= 5.1 MM Ac.
Area compilation		=	18.2	"	= 6.0 MM Ac.
Volume compilation		=	25.9	"	= 8.5 MM Ac.
Average			20.4		6.7 MM Ac.

Area covered will include six complete counties, portions of four others, and one subregion.

d. Compile growth data on punch cards for 9.0 million acres.

e. Complete adjustment of general form class tables to survey sample-tree data for major coniferous species (PP, SP, WF, DF, RF) and localize volume tables applicable for one subregion.

f. Prepare volume tables for second-growth redwood in Scribner Dec. C and International 1/4-inch log rules, and for cubic sawlog volume and cubic volume to 4-inch top.

g. Complete compilation of fire mortality data and compile natural mortality estimates for Coast Range pine subregion.

h. Determine sampling errors by age-density classes, and compile average volumes and coefficients of variability by stand classes, for area sampled through 1948.

i. Compile average 10-year growth and coefficient of variability by stand classes, for area sampled through 1948.

j. Devise site classification for old-growth redwood based on virgin stand volumes; also a map of redwood sites.

k. Prepare factors for converting old-growth redwood volumes expressed in Spaulding rule (equivalent to Scribner) to International 1/4-inch rule and to cubic volume, and compile volume estimates for old-growth redwood adjusted to survey standards.

l. Prepare mensuration sections of survey manual, proposed for both intensive and extensive surveys, and revise other sections of manual as necessary.

m. Plan the Survey's county statistical and subregion analytical reports; prepare Siskiyou, Trinity, Lake, Napa, Glenn, Sonoma and Colusa County reports for release; and assemble general descriptive material for the Coast Range pine subregion report.

Drain and Requirements

n. Complete field work for logging waste study of 5 large operations; compile results; and produce report on this phase of drain for both pine and redwood regions.

o. Conduct a sample canvass of lumber production for 1948 in the seven southern counties of the redwood region, and supplement, if necessary to obtain adequate coverage, the canvasses of (1) the West Coast Lumbermen's Association in the two northern counties of the redwood region and (2) the Western Pine Association in the pine region.

p. Conduct a survey of production of plywood, veneer, cooperage and pulpwood for 1948.

q. Compile results of production in 1948 from both our own and trade association canvasses, and publish results as a Station Research Note.

r. Cooperate with the Washington Office in making as complete as possible their survey of wood used in manufacture in 1948. This mainly involves the secondary wood-using plants.

2. Forest Economics Research

The Division plans to continue its informal cooperation in the study of the economics of sugar pine management and blister rust control. During the coming year, emphasis in this project will be devoted to (1) completing the analysis of the effects of stand age, density, type, and site on costs of management and blister rust control, and (2) developing a basis for classifying cut-over lands in terms of the economic feasibility of managing sugar pine thereon.

3. Other Activities

a. Continue State Division of Forestry cooperation, including:

Intensify the classification of timber cropland, range, and watershed land from aerial photographs for 3.0 million acres (75 quadrangles) included under (a) of Inventory plans for 1948.

Complete the field work for type and site mapping and soils classification for 1.0 million acres (29 quadrangles).

Prepare for distribution 160 Timber Stand maps (5.8 million acres) and 40 Vegetation and Soil maps (1.4 million acres).

Compile acreages of the various classifications by ownership for southern Mendocino County and prepare preliminary report of ownership for the entire county by combining the results of this study with the one previously made for the northern part of the county.

Revise the field manual for vegetation and soils mapping as needed.

b. Conduct a training school in photogrammetry and photo classification techniques for new survey personnel.

c. Keep cooperative ownership study with the BAE abreast of the field and office work in the inventory. This will consist of punch card compilation of ownership data for 7 counties (6.6 million acres) and the completion of the field survey of type, size, value, and intent of ownership for an equivalent area. Prepare ownership reports as supplements to county statistical reports (areas and volumes) to be released during the year.

d. In cooperation with the Northern Rocky Mountain Forest and Range Experiment Station prepare a detailed survey work plan for the area remaining in the Rocky Mountain territory, Regions 2, 3 and 4. The plan will cover such items as allowable funds, accuracy controls and specifications, discussion of alternative survey methods, description of proposed survey, organization and division of work, and relation of proposed survey and organization to probable costs and required allotments by years and by states and by cooperating stations. If the work is initiated this year a manual of field instructions will also be prepared.

FOREST UTILIZATION SERVICE
(L. N. Ericksen, Chief of Division)

Objectives

1. Seasoning of Wood

a. Follow-up experimental work on seasoning of hardwoods done at Madison, by use of a portable experimental kiln in the field.

b. Conduct experimental work on kiln drying of California black oak with same equipment.

c. If suitable cooperation can be arranged, carry out air seasoning tests on black oak and some of the other hardwoods, probably in conjunction with the kiln-drying work.

d. Follow up experimental work in seasoning white fir to check on suggested schedules.

e. If interest warrants, arrange demonstration course in kiln drying in southern California or in the pine region.

f. Investigate practicability of designing a kiln suitable both for dehydrating fruit and drying lumber.

2. Utilization

a. Continue studies of utilization possibilities of local hardwoods; veneer and lumber, properties, working qualities, etc.

b. If Forest Products Laboratory can undertake study of design and nailing of containers for fruits and vegetables, work with them on field phases of the problem.

c. Follow up with industry on experimental work on veneer and plywood from white and red fir.

d. Carry out the sawmill waste survey.

e. Encourage better utilization practices by dissemination of results of research to interested manufacturers and users of forest products.

Activities and Accomplishments

The past year has seen important developments in wood utilization in the State. Probably the most significant in broadening the base of utilization is the Masonite board plant planned for the southern part of the redwood region. This plant, together with the pulp mill under construction in the Sacramento River delta, will offer markets for substantial volumes of low grade and small trees and logs, slabs and edgings,

and veneer bolt cores. Several mills are already chipping slabs and edgings for stockpiling of chips at the pulp mill, which will begin operating in 1949.

A smaller but no less interesting project was the building of a plant at Sacramento to produce compressed board from box factory waste using synthetic resins to bind the dry, finely divided wood wastes.

Plywood production is growing rapidly. One large modern plywood plant at Eureka, using Douglas-fir and redwood, came into production late in the year; another at Fairhaven on Humboldt Bay will go into production early in 1949. Still another, using pine, went into production in the northern end of the Sacramento Valley.

The "whitewoods" of the redwood region appear to have reached a sound utilization base. Douglas-fir is the principal wood used by the plywood industry. Many small mills are producing fir lumber, and larger redwood mills are cutting up to 25 and 30 percent fir. They are producing edge-grain flooring and similar high-value items.

Dry kiln construction and modernization has increased at mills and in wholesale and remanufacturing yards in both northern and southern California. This reflects the realization that properly seasoned stock will be essential if the operator is to hold his place in the market.

At the request of several operators interested in manufacture of California black oak, experiments in air drying and kiln drying were started.

Seasoning

The work with California black oak was quite encouraging. A portable experimental dry kiln holding 500 to 600 board feet of lumber was brought from Madison for seasoning studies. It was set up at the sawmill of a company having a quantity of oak which it is interested in manufacturing into flooring. In order to simplify the seasoning problem as much as possible, the oak was cut green into 3/4-inch by 3-inch strips. This stock was first air-dried and then several lots were kiln-dried, using different schedules to determine best drying conditions. Following this, some 15,000 feet of oak strips were dried in the company's kiln, run into strip flooring, and sold through several of its retail yards.

It was found that the oak could be dried with good results in both the air seasoning and kiln drying stages. Three-quarter inch stock was air-dried to a moisture content of 20 percent in 32 days and to 10 percent in only 58 days during the active drying season of June, July and August. Despite this fast drying during severe weather, there was no surface checking and similar drying degrade. Similar stock may require at least twice as long for air drying during the wet winter weather. The kiln drying of this previously air-dried 3/4-inch stock was relatively easy. It probably can be dried in a modern forced-circulation fan kiln in less than 3 days without drying defects.

The company had been concerned about drying the wood, but largely as a result of this work, the firm is planning to manufacture oak flooring on a fairly substantial basis. It contemplates setting up a mill and supplementary equipment designed especially to manufacture California black oak. Several other operators would like to utilize oak, and we hope that this work will help solve the seasoning problem, which in large part has been a deterrent to the successful use of this wood.

Considerable interest being shown by industrial firms in both southern and northern California, a dry-kiln demonstration was scheduled for January 1949 at Los Angeles. Arrangements were made with a local company for classroom and demonstration facilities, and a number of firms were interviewed to discuss drying problems and to enroll persons in the demonstration. Among the interested companies are industrial firms, importers, wholesale yards, and sawmill operators from northern California.

At the request of interested operators the Forest Utilization Service unit assisted in the organization of a dry kiln club in the central California area, including the San Francisco Bay region. This group of dry kiln operators offers a meeting ground for the exchange of information on kiln operating techniques. The group has requested continued assistance in an advisory and consulting capacity.

Kiln schedules for white fir have been discussed with a number of operators. The tentative schedule developed by the Forest Products Laboratory last year, which employs higher temperatures than have been used by some operators, has worked out quite well in actual practice. It is felt that operators have been somewhat conservative in their schedules for white fir and could use higher temperatures without damaging the lumber.

Although fruit dehydrators continue to be used for drying lumber, inquiries on this subject have fallen off. We have discussed the question of a dual purpose dryer, for fruit and for lumber, with technicians at the College of Agriculture, University of California at Davis. Apparently not many dehydrators are being built at present. If such construction increases, we believe it will be possible to design a dryer which will be suitable for both purposes.

Utilization

The reports of Forest Products Laboratory research on production of veneer, working qualities, and properties of local hardwoods have been useful in answering inquiries throughout the year. Plywood operators and others who are planning lumber operations have been interested in the information on these woods.

Information on the production and seasoning of veneer from white fir and California red fir has been used by several operators who are considering the establishment of a plywood plant. We have furnished them other background data bearing on their project. One important

factor for which information is lacking is the comparative value of logs converted into plywood and into high-grade lumber. This, of course, applies particularly to ponderosa and sugar pines, which produce lumber of high value, and are included in the contemplated plywood development.

Because the Laboratory was unable to undertake experimental work on the nailing of boxes for fruits and vegetables, the proposed work in this field was deferred. It contemplated a study of types of nails, with particular reference to use in thin material and the design of light weight containers for agricultural products. Emphasis would be given to improving the technique for nailing white fir. Information on these points is basic to improvements in technique of wood box manufacture, and it is hoped that this work can be undertaken next year.

At our request the Forest Products Laboratory made analyses of several chaparral species which we collected in the Mt. Shasta area. The results were similar to those obtained with hardwood waste at eastern mills: yields of 36 to 43 percent of sugars may be obtained from chaparral on a dry basis. The type of sugar produced is suitable for yeast production and appears to be suitable for livestock feed. Included in the analyses were snowbrush, buckbrush, manzanita, and chinquapin.

The utilization of chaparral, or brush species is regarded as being of considerable importance in the State. This is shown by one of the recommendations of a specialist engaged by the University of California to make an analysis of brush problems in the State. Along with recommendations for control of brush and its use as forage, he urged that its potential industrial uses not be overlooked. He recommended: "That you secure the ablest and most experienced wood technologists and cellulose chemists that can be found and put them to work on the separate brush species with a view to ascertaining the properties of their wood and fiber, mechanical and chemical". The work at the Forest Products Laboratory is only the first step in this direction.

A number of sawmill operators have shown considerable interest in the report on cut stock possibilities in the middle west. This report outlines the results of a survey made by the Forest Products Laboratory to determine the species, grades, and sizes of stock that could be purchased direct from the mill. Interest in the possibilities of more cut stock production reflects the trend toward more complete utilization at the mill. The opportunities for greater return per M feet of logs and for broadening the employment base, thereby stabilizing communities, are potent factors behind the move toward more production of cut stock.

Owing to lack of manpower and facilities, the Unit was unable to carry out the sawmill waste survey mentioned in last year's report.

We have worked with technicians from the Forest Products Laboratory on working stresses for structural material in building codes and on laminated construction. Working stresses basic in building codes generally, have been discussed at meetings of engineers and building code officials and with State and city engineers, who design and supervise construction. These two subjects are closely allied in the building and construction fields and represent an important field of wood use.

During the year there have been requests for information on sources of supply for companies contemplating plant construction, on processes for production of fiberboard from waste material, on gluing, wood properties, dry kiln construction, wood treatment, and allied subjects. Unit personnel has assisted in the organization of groups interested in better utilization and has taken part in programs on the subject.

Plans for 1949

1. Seasoning of Wood

a. Continue experimental work in kiln drying of California black oak.

b. Further the development of kiln schedules for white fir.

c. Endeavor to develop techniques for better control of brown stain in pine.

d. Study basic principles in drying with direct-fired as compared with indirect (steam coils) heated dry kilns. (Would be an F. P. L. project).

2. Utilization

a. Develop better techniques for resawing white fir. (Would be an F. P. L. project).

b. In cooperation with F. P. L. develop better nailing techniques for assembly of lightweight agricultural boxes.

c. Hold a wood-conditioning and gluing conference if interest in southern California warrants.

d. Develop information on optimum conditions for production of veneer from redwood; also study veneering of Douglas-fir from Sierra Nevada.

e. Work with College of Agriculture, University of California at Davis on analysis of wood sugar molasses and preliminary feeding tests.

RANGE RESEARCH
(M. W. Talbot, Associate Director, In Charge)

Work of this Division is reported upon, for convenience and clarity, by the three main activities: grazing management in the mountains, grazing management in the foothills, and reseeding.

Mountain Ranges (A. L. Hormay, Project Leader)

Objectives

1. Complete the manuscript covering the major findings at the Burgess Spring Experimental Range to date.

2. Limit field work to checking soundness of Burgess Spring results and general applicability in the eastside region.

3. Continue assistance in developing the artificial reseeding program in northeastern California.

Activities and Accomplishments

Burgess Spring Manuscript

The analysis of 13 years of experimental work at the Burgess Spring Experimental Range on the management of summer mountain cattle ranges in northeastern California is nearing completion. The information is being shaped up for release in a USDA circular.

This study has shown the need for adjustments in basic management factors like frequency, season and distribution of grazing, and stocking rates. For example, periodic resting of the range seems essential. Season-long grazing as now generally practiced has proved harmful to the range at almost any level of stocking within practical limits. Cattle tend to graze certain choice species and choice areas more heavily than others year after year. The better forage species are thus gradually killed out, resulting in range deterioration and loss of livestock production.

Also, the grazing season must be geared as closely as possible to plant growth and development. The Burgess Spring tests show as much as 30 days variation in range readiness from one year to the next, and holding the grazing season to fixed calendar dates is harmful to both forage and livestock. Too early use of the range in relation to plant growth reduces the seasonal production of forage and also injures the plants; too late use results in loss of livestock production.

Overstocking, which prevails too generally on ranges in northeastern California, stems in a large measure from a tendency to overestimate grazing capacity. This tendency is due to a lack of full appreciation of what comprises the forage, what areas can be grazed, and how much vegetation must be left on the ground to maintain range productivity. Much practical information has been gathered on these points.

Better distribution of cattle is greatly needed to help even out grazing and to effect more efficient utilization of the entire forage crop. In northeastern California this can be accomplished mainly with more fences and water developments. Fences are needed for other phases of management, such as carrying out a deferred grazing system, and a sound artificial reseeding program for which there is great need.

These findings are supported by the data gathered on weather, soils, vegetation, and livestock factors; to make them of practical value to stockmen and other range administrators, an economic analysis will be made of the cost of good range management on an actual range unit. During the summer a detailed range survey was made of the Harvey Valley range allotment adjoining the Burgess Spring Experimental Range to provide some of the physical facts needed for a case example. Among other things, this analysis will bring out whether or not it would pay a private operator to put in the necessary facilities like fences and water developments and carry out practices like artificial reseeding and deferred grazing on ranges of the type studied. It will bring out the magnitude of the investments needed to rehabilitate partly deteriorated ranges.

Other Activities

Hormay prepared a paper on "Getting Better Records of Vegetation Changes with the Line Interception Method" for presentation at the annual meeting of the American Society of Range Management at Denver in January 1949. It was accepted by the Journal of Range Management for publication in April.

Plans for 1949

1. Complete the manuscript covering the major findings at the Burgess Spring Experimental Range. This report will make results widely available and will provide the basis for a comprehensive working plan for the next phase of the research program.

2. Continue assistance in developing the artificial reseeding program in northeastern California.

Foothill Ranges (J. R. Bentley, Project Leader)

Objectives

1. Complete revision of manuscript for Departmental circular in line with comments from Board of Review and Washington office.

2. Develop the working plans for the next phase of the joint research program at the San Joaquin Experimental Range.

3. Continue limited work on the effects of weather on annual-plant forage, effects of fertilizer on range forage, reseeding, and liaison with brush control studies.

Manuscript for Departmental Circular

The manuscript was rewritten to incorporate the suggestions from the Board of Review and Washington office, and was reviewed by Chapline in November. He made suggestions for limited changes to improve clarity. These changes will be made and the circular presented for publication in 1949.

Operational Plan for the San Joaquin Experimental Range

An operational plan was prepared to show how most of the pastures and cattle will be used in a set of cooperative pasture experiments during the next period of study. This over-all plan was approved in November at a meeting in Davis with Chapline and members of the University and Station engaged in work at the Range. After review by the Advisory Committee it will serve as a guide for initiating new studies and operating the Range.

The plan has two main features: (1) a few problems of first priority will be studied in detail with weaner calves; and (2) new methods of range improvement or cattle management, developed and evaluated in detailed studies, can be demonstrated on larger areas with the breeding herds. By calibrating production from the cow herds before the treatments are applied, continuous production records from the herds will yield a maximum of research information with a minimum of technical manpower.

The available calves will be used in groups of approximately 10 head in small pastures to make detailed studies of the effects of weather, fertilization, reseeding, brush control, and rodent control. Other young animals will also be used for progeny tests and to evaluate different supplemental feeds.

The breeding cows will be divided into two herds of 40 to 60 head each and one small pilot group of about 12 head. The cows will be fed supplements and grazed under moderate stocking (practices recommended from past work). The small group will be carried year-long in one pasture to determine whether or not under year-long grazing the evidences of increased occurrence of deformed calves, lower calf crops and lower weaning weights that occurred in the "C" herd in pasture 13 are valid. Each of the two larger herds will be grazed in two or more pastures during the year. They will be carried with only routine feeding, handling and weighing until the number in each herd is adjusted to the available area, and levels of production from the two herds are calibrated (until weaning time in 1950 or later). After the period of calibration, the two herds can be used in tests such as (1) improvement of one area by fertilization, reseeding and brush control, with the other area (with its herd) kept as an untreated check; (2) rodent control on one area with the other as a check; (3) creep feeding of calves in one area with the other as a check; (4) study of factors influencing cattle reproduction. Probably only one, or possibly two, of these tests can be conducted at one time and still evaluate each practice. Priorities of the

various tests will depend upon recommendations by the Advisory Committee, experimental requirements of the studies making necessary running of one test before the other, and availability of funds for conducting the work.

Other Activities

Field work on the fertilizer studies was held to a bare minimum for another year, being limited to observations of residual effects from previous fertilizer applications. In general, growth of clover was sparse on all plots although stimulated slightly by sulfur-bearing fertilizers. Heavy applications of gypsum (500 and 1000 pounds per acre) and of sulfur (100 and 200 pounds per acre) in the fall of 1945 still gave a very noticeable increase of clover on slope soil. A slight hold-over effect of nitrogen was shown by the greater growth of grass in the fall on the gypsum plot that was last fertilized in February 1945. The grass was thinned, however, by the drought in January 1948, and by May there was less grass on the unfertilized plot. Because of poor legume growth in 1947, there was no hold-over effect of nitrogen on plots fertilized with gypsum or superphosphate in the fall of 1946. The outstanding forage yields, especially in grasses, occurred on the plots receiving heavy applications of phosphorus (200 pounds of treble phosphorus per acre) along with gypsum in the fall of 1945. These were the first plots to show definite responses from phosphorus in addition to sulfur on both slope and swale soils at the Range. They raise additional questions on fertilizer requirements, to be determined by more intensive work.

Liaison with the brush control studies was limited to cooperation with the State Division of Forestry at the Clark Administrative Site and to examination of brush problems with other workers. Two areas at the Clark Site were burned and the small areas of heavy ash were seeded.

Work in progress at the San Joaquin Experimental Range was explained to more than 600 visitors during the year.

Plans for 1949

1. Submit final manuscript on management of annual-plant ranges for publication as a Departmental circular.

2. Summarize results from supplemental studies of range fertilization and reseeding and publish in technical journals or agricultural press.

3. Survey the set of small pastures intended for detailed studies, including measurement of site-classes and rock or tree cover, and measure total herbage production of each pasture at plant maturity.

4. Develop additional techniques for forage growth measurements needed in the detailed pasture studies.

5. Prepare detailed study plans for the small-pasture studies of fertilization and rodent control and start the work.

6. Continue reseeding studies and limited liaison with brush control studies. Intensify studies of fertilizer requirements of range forage on soils of granitic origin.

Range Reseeding (D. R. Cornelius, Project Leader)

Objectives

1. Incorporate the information into the State-wide problem analysis and work plan for a comprehensive reseeding project.

2. Conduct spot studies on several national forests and from the San Joaquin Experimental Range for test of selected sites, suitability of species, and methods of land preparation and seeding.

3. Continue to cooperate with the Agronomy and Extension Departments of the University of California, the Soil Conservation Service, and other State and Federal agencies in planning for continued coordination of range reseeding programs.

Activities and Accomplishments

Status of Problem Analysis

All available information necessary for the analysis of range reseeding problems has been assembled. Information has been obtained from literature, experimental plantings by the Station, pilot plantings by national forests in Region 5, and plots and fields reseeded by other agencies and ranchers. Writing of the report on the problem analysis and work plans is progressing rapidly.

Zones Affording Best Response to Range Reseeding

In general, reseeding offers most promise for improvement of depleted summer ranges in two zones: the Great Basin sagebrush and the lower pine forest zones of northeastern California. Therefore, these two zones are receiving priority for research in reseeding. In them successful reseeding is favored by such important factors as length of growing season, general depth, fertility and stability of soil, availability of seed of adapted forage species, and the extent of areas in need of reseeding.

True, there are ranges badly in need of revegetation at higher elevations, in the upper pine forest and in the sub-alpine zones. However, the individual units in these zones are usually small and often inaccessible for large-scale equipment. The growing season is exceedingly short and climatic conditions are hazardous to successful establishment of seeded forage plants even though annual precipitation may be higher than that of the other zones.

At the lower elevations reseeding is being considered on ranges of the chaparral, woodland-grassland, and grassland zones. There is a great need to convert some of the ranges of the chaparral zone with unpalatable brush to ranges with palatable forage species. Likewise, some of the grassland ranges now dominated by annuals would be more profitable, if not more productive of forage, if successfully reseeded to perennial grasses or legumes. This would provide green feed later in the summer and earlier in the fall than is provided by the exotic and native annuals now controlling the ranges. Past work indicates that considerable long-time research will be needed before large-scale reseeding can be safely recommended for these ranges of lower elevation. The greatest problems are to develop techniques for reducing competition and for seeding, to select species that will persist, and to devise management methods that will maintain the reseeded range in a state of high productivity. Several of the forage plants showing greatest promise for reseeding these ranges are not commercially available at present, and some, such as the needlegrasses, offer serious difficulties for seed producers. In general, the present annual-type ranges of the grassland and woodland-grassland zones are capable of producing sufficient cover to resist erosion and have reasonably high annual production of forage.

It seems advisable to continue the research on the high- and low-elevation ranges on an exploratory basis, with a few cursory test plantings. The priority for immediate and intensive study should be assigned to the depleted ranges of the Great Basin sagebrush and lower pine forest zone.

Suitability of Species and Sites

Reseeding trials during the year show that forage yields on the best sites can be increased 2 to 10 times. Yields were measured on reseeded plots and adjacent depleted range in three different areas: one at Antelope Sink on the Shasta National Forest, and two, at Saddle Blanket and Mud Lake, on the Modoc National Forest. The conditions represented were:

Characteristic	Antelope Sink	Saddle Blanket	Mud Lake
Zone	Lower pine forest	Great Basin sagebrush	Lower pine forest
Native vegetation	Big sagebrush	Big sagebrush	Black and silver sagebrush
Elevation, feet	4500	4300	4600
Annual precipitation, inches	13	10	22
Soil texture	Clay loam	Porous loam	Heavy clay
Soil depth	3-4 feet	3 feet	1½ - 2 feet to impervious clay layer
Age of field, years	3	2	2

Yields were determined by clipping milacre quadrats -- in 1947 and 1948 on the Shasta area and in 1948 on the Modoc areas. In pounds of dry grass per acre, the forage yields were:

	Antelope Sink		Saddle Blanket	Mud Lake
	1947	1948	1948	1948
Areas planted with:				
Crested wheatgrass	1446	1415	1027	423
Slender wheatgrass	1039	1615	445	473
Bluebunch wheatgrass	1226	973	-	-
Smooth bromegrass	897	1274	272	447
Mountain bromegrass	-	704	488	-
Timothy	-	-	-	845
Unplanted areas:				
Depleted sagebrush range	126	432	406	275
Abandoned farmland	18	135	-	-
Note: Least significant mean difference 5 per-cent level	-	72	192	152

These results were obtained with equipment and methods available at the beginning of the reseeding project. Better equipment and methods are now being used. Greater returns from reseeding may be expected from better control of competing vegetation and preparation of seedbed. These preliminary results show high promise for the improvement of large acreages of depleted ranges in northeastern California when sites, species, and methods for reseeding are carefully chosen.

Conditions at the San Joaquin Experimental Range were unfavorable for reseeding during the 1947-48 season, with precipitation below normal and occurring in a short period in the spring. The dry fall period was not conducive to satisfactory germination and the long dry summer period was unfavorable for seedling survival. A mixture of grasses and legumes drilled on summer fallow and on sudan stubble areas gave fairly good emergence for tall fescue, Harding grass, subterranean clover, and bur-clover. One year later most of the tall fescue and Harding grass had died and stipa gave the highest percentage of seedlings, although the stand was sparse. The subterranean and bur-clover produced some viable seed.

Studies of Land Preparation, Sites, and Seeding Rates

That complete eradication of all competing vegetation ahead of seeding enhances the chances for successful establishment of the forage species was markedly shown in a test on the Lassen National Forest. Replicated strips, over 1000 feet in length and 25 feet in width, were prepared in the summer by four different methods ahead of planting a mixture of forage grasses by drilling in October 1947. The methods tested and the number of seedlings per square foot were as follows:

Treatment in July and August, 1947, previous to drilling seed	Seedlings per square foot, August, 1948
Plowing with disc plow	5.7
Double discing with light offset disc	3.5
Plowing with one-way Wheatland plow	2.5
Mowing with tractor mower	1.9
Least significant mean difference at 5 percent level	1.4

Plowing with the disc plow completely eradicated the competing sagebrush. The other plowing, discing, and mowing treatments permitted increasingly greater survival of the sagebrush.

The test strips crossed three kinds of sagebrush sites: big sagebrush, black sagebrush, and silver sagebrush. Establishment of grass seedlings differed significantly for the three sites, the big sagebrush site averaging 2.4 grass seedlings per square foot; black sagebrush, 5.6; and silver sagebrush, 1.4. Surface soil of the big sagebrush area had low water-holding capacity and apparently dried out too quickly for optimum seedling emergence. The black sagebrush area had soil of the desired texture for seedling emergence and survival. Heavy textured clay soil of the silver sagebrush area was undesirable for good growth of seedlings. The water-holding capacity of the clay soil was high but the amount of moisture available for plant growth was low; consequently, the grass seedlings were small and the stand was sparse. Flooding of the silver sagebrush area in the early spring for about 10 weeks also delayed and reduced emergence of the grass seedlings.

A rate of planting test had been conducted on an area of big sagebrush-cheatgrass range which was plowed with a one-way Wheatland plow in the summer of 1946. In October 1946, crested wheatgrass seed was drilled at the rate of 6, 9, 12 and 18 pounds per acre. The yield of crested wheatgrass in August. 1948, dry weight per acre, averaged 597, 857, 853 and 856 pounds respectively for the four rates. Under the conditions of this test, 9 pounds per acre proved optimum. Six pounds of seed per acre broadcasted by hand gave a yield of only 162 pounds of forage per acre. For the entire test a difference of 149 pounds was necessary for significance at the 5 percent level.

New Cooperative Test

In northeastern California the lack of available feed or pasturage on the home ranch units in the spring has induced earlier grazing of mountain ranges than has been desired by the range managers. This early grazing has contributed to the depletion of some of the grazing area of the Warner Mountains of the Modoc National Forest. Many of the ranch units have big-sagebrush ranges that are producing very little forage. If some practical means can be used to eradicate the sagebrush and reseed the ranges to desirable forage grasses and legumes, the pressure to graze the mountain ranges too early in the season may be

relieved. Consequently, a test of reseeding possibilities was deemed worthwhile by the Station and the Region 5 Range Management Division. Working through the Modoc National Forest and one of the permittees, a trial was started in depleted big sagebrush range at the edge of Surprise Valley, which might provide spring and early summer grazing. A 45-acre area was plowed in the summer of 1948 to be seeded to crested wheatgrass and dry-land alfalfa. Field plots will be included to test three other wheatgrasses, two dry-land legumes recently introduced, and two promising native grasses.

Plans for 1949

1. Intensify study of sites for reseeding and study of species and strains for range use in lower pine forest and Great Basin sagebrush zones. With Hormay, develop plans for management studies of reseeded range areas in these zones.

2. Study time and rate of applying 2,4-D on different species of sagebrush, rabbitbrush, and certain meadow weeds to precede reseeding.

3. Compare different methods of preparing the land for reseeding on the San Joaquin Experimental Range by drilling several grasses and legumes into areas of summer fallow, sudan grass stubble, and annual range that has been sprayed with weed killing oil.

4. Continue observation of pilot plot and field seedings made by Region 5 on the several national forests, and cooperate with other Federal and State agencies in coordinated plans for reseeding research.

5. Complete the writing of the State-wide problem analysis and work plan for the range reseeding project.

FOREST INFLUENCES

(C. J. Kraebel, Chief of Division)

Objectives

1. Continue operation of the San Dimas Experimental Forest and the compilation of accumulated data.

2. Complete manuscripts for publication by State of California and U. S. Department of Agriculture.

3. Carry forward the preparation of other manuscripts.

4. Continue special rainfall studies toward simplifying the job of rainfall measurement.

5. Install and test operation of fiberglas soil moisture units.

6. Prepare for use of forest officers a description of the vegetation, soils, and geology of the national forests of southern California.

7. Continue field studies of soil stabilization in burned areas, with emphasis on improved erosion control treatments and the measurement of erosion in treated and untreated areas.

8. Continue cooperation, in-Service and out, in the interest of broader, better understanding and practice of good watershed management.

Activities and Accomplishments

Accomplishments for the year were modified by the loss of H. C. Storey for a good part of the year, first through his attendance at the Washington Office statistical school and the Forest Influences Conference at Franklin, North Carolina, and later by his transfer to the Northeastern Station.

The Station's research program was broadened by the initiation of physiological studies of chaparral, with special reference to the problems of watershed cover improvement. E. C. Stone was assigned to this project and stationed at San Dimas. The phases of these studies requiring laboratory and greenhouse facilities are conducted at the California Institute of Technology under cooperative agreement with the Station. The growing of stock, and some field tests, are done through cooperation with the Forest Service Flood Control Project in the Los Angeles River watershed.

A detailed analysis of forest influences problems in the California region got under way late in the year. On December 3 Colman

started on a tour of forest influences research centers throughout the United States to examine their problems and methods. Intended originally to provide a background for the analysis of regional problems, this extensive study will be of value also in the national problem analysis.

San Dimas Experimental Forest

All activities, including operation of the forest, collection of records, compilation of data, and preparation of manuscripts, were materially assisted by financial aid from the State of California through the State Division of Forestry. This State aid permitted the technical staff to devote full time to the analysis of data and the preparation of manuscripts for publication. The experimental forest was visited by 550 people during the year, including 19 from foreign lands.

Manuscript Preparation.- Two bulletins were published by the State of California under cooperative agreement between the Station and the State Board of Forestry:

Influence of Woodland Chaparral on Water and Soil in Central California, by P. B. Rowe.

Geology of the San Gabriel Mountains, California, and its Relation to Water Distribution, by H. C. Storey.

Three other manuscripts for this cooperative series were made ready for technical review. These include one based on Fire Damage Appraisal data giving estimates of the influence of fire on peak discharge and erosion from 256 mountain watersheds, a report on 11 years of interception and stemflow measurements in brush types at San Dimas and North Fork, and a summary of present knowledge on trees and shrubs to use for erosion control planting.

Preparation of the descriptive reports on the vegetation, soils, and geology of the national forests in southern California for the use of forest officers was deferred because of work on manuscripts for publication.

Precipitation.- Studies were continued to improve the accuracy of rainfall measurement in mountain watersheds with the minimum number of samples possible. The San Dimas Experimental Forest rain-gage network of 170 vertical gages was paralleled with a system of tilted slope-facet gages by the installation of 30 additional tilted gages, thus providing a network of 67 gages in the latter system. The winter of 1947-48 was the driest of record on the Forest, but several storms occurred of sufficiently high intensity, or accompanied by high winds, to produce some interesting results.

1. It was found that satisfactory isohyetal maps could be drawn by using data from the tilted rain-gage network. The total amount of precipitation falling on a watershed, as determined from these isohyetal maps, agreed closely with the arithmetic average of the tilted gage catches. This confirms findings previously reported by Storey and Wilm from a smaller area (Transactions, A.G.U., 1944, p. 513).

2. Another study was made to determine whether the average rainfall catch of the several watersheds within the Experimental Forest, as measured by the extensive rain-gage network, could be measured as accurately by fewer gages specifically located for the purpose. Gages were selected for this study from the vertical, the tilted, and the intensity gage networks. In general the criteria for selection of these gages were that each watershed should be sampled near its mouth by one vertical gage located in the canyon bottom, and in its upper portion by one or two tilted gages representative of the upper slope facets. Six rain gages of various types were specially installed to complete this network, which in the end comprised 20 gages, several of which served two or more adjacent or "nested-cup" watersheds. As finally set up, the system consists of 10 recording and 10 non-recording gages. The results of the study indicated that:

a. The average annual forest-wide rain catch, as measured by the 20-gage network, varied less than 1 percent from the average obtained from either the vertical gage network of 170 gages or the tilted gage network of 67 gages.

b. The average annual rain catch of individual watersheds differed by less than 2 percent from that of the other networks.

c. The catches by storms for individual watersheds were more variable — ranging from less than 0.5 percent for mild storms to 10 percent for storms accompanied by wind and snow.

In general this study points the way for the development of a less complicated rainfall measuring system than the extensive network of many gages now in use.

3. Investigation was made of the possible effect of wind on the catch of standard height (40 inches) vertical rain gages by installing one-foot-high gages adjacent to 19 standard gages in the extensive vertical network at exposed, windy locations. The study showed that the 19 low-level gages caught more rainfall than the corresponding gages of standard height. The differences by storms ranged from 0.1 percent to 5.7 percent, with small-sized and comparatively windless storms showing the smallest difference in catch. For the 1947-48 rain season, the low gages have a total rainfall catch 3.3 percent higher than the conventional high gages.

Streamflow and Erosion.- Maximum flows and total water yield recorded from the 17 watersheds within the San Dimas Experimental Forest were very low, owing to the lack of intense storms and a 50 percent deficiency in seasonal precipitation. Erosion from all watersheds within the Experimental Forest was negligible except that some debris came from Keril Canyon just below Big Dalton dam. About 130 acres of this small watershed were burned in July 1947.

Progress was made with the compilation of accumulated streamflow data from the Experimental Forest. The daily and seasonal stream discharges were compiled for 68 watershed years, completing the summaries of streamflow from 13 watersheds from the time the records were started up to October 1, 1948. About 20 watershed years of past records remain to be compiled.

Interception.- Data were analyzed from an interception study conducted for 6 years in a 60- to 80-year-old second growth stand of ponderosa pine at Bass Lake in Madera County. Results are summarized in the following table:

Year	No. of storms	Precipitation	Throughfall	Stemflow	Interception loss	Throughfall	Stemflow	Interception loss
		Inches	Inches depth			Percent of precipitation		
1940-41	41	58.53	48.62	2.34	7.57	83	4	13
1941-42	35	49.76	41.59	1.67	6.50	84	3	13
1942-43	40	50.90	42.85	2.53	5.52	84	5	11
1943-44	43	37.70	31.68	.88	5.14	84	2	14
1944-45	33	50.29	43.06	1.63	5.60	86	3	11
1945-46	22	37.53	32.01	.83	4.69	85	2	13
Average	35.6	47.45	39.97	1.65	5.83	84.3	3.2	12.5

Throughfall, precipitation passing through or reaching the ground as drip from the vegetation canopy, averaged about 84 percent of the annual precipitation. Stemflow, that part of the annual precipitation intercepted by the vegetation and reaching the ground as flow down the tree trunks, was about 3 percent. Interception loss, the precipitation intercepted and evaporated directly from the vegetation, averaged about 13 percent. In general, the percent of interception loss decreased as size of storm increased, and was smaller for seasons of high than for seasons of low precipitation. In storms with precipitation principally as snow, throughfall was slightly greater and stemflow and interception loss slightly less than in storms of rain alone.

Soil-Moisture Instrument.- Forty-four fiberglas soil-moisture units were calibrated in stock lysimeter soil under laboratory conditions. Several new findings regarding the behavior of the fiberglas units resulting from these calibrations and other tests were described in a manuscript submitted for publication in Soil Science.

Thirty-two of the calibrated moisture units were placed in the soil in 2 large and 2 unconfined lysimeters planted to oak and pine respectively. Eight units were installed in each lysimeter at depths of 6, 12, 18, 24, 30, 42, 54, and 66 inches from the surface of the soil. The remaining 12 units were placed in a plot near the lysimeters at depths of $1\frac{1}{2}$, $4\frac{1}{2}$, $7\frac{1}{2}$, and $10\frac{1}{2}$ inches from the surface. These units will be tested under field conditions through wetting and drying cycles of soil moisture to check the calibrations hitherto made in the laboratory.

The soil-moisture instrument has continued to require considerable attention by Colman. The manual was revised following tests of the units in soil moistened with distilled water to eliminate the cumulative electrolytic effect of salts in ordinary tap water. Total sales of the instrument through December 31, 1948, as reported by the manufacturer, amounted to 986 soil units and 24 ohmmeters. Pending completion of the patent proceedings, the Berkeley Scientific Company (601 Nevin Avenue, Richmond, California) has been licensed to manufacture and sell the instrument. Granting of the patent to Colman, and its assignment to the U. S. Government, is not expected before mid-1949.

Lysimeter Studies.- The low rainfall of only 15.83 inches at Tanbark Flat during the winter of 1947-48 increased soil moisture in the large lysimeters to a depth of 30 to 36 inches, but did not replenish the water lost by evaporation and transpiration during the summer of 1947. Even though the plants were given supplementary water (equivalent to 4 inches depth) during June 1948, they lived under severe moisture stress through the summer and fall. Soil moisture samples taken during October 1948 in each of the 26 large and the 5 unconfined lysimeters showed that the moisture throughout the 6 feet of soil was at or below the wilting point in each lysimeter in which plants are growing, irrespective of species.

Soil moisture in the one tank that is kept bare was above the wilting point at all depths except the top 6 inches. The wilting point of the lysimeter soil is between 7 and 8 percent moisture content, or an equivalent of 8 to 9 inches depth of water in the tanks. Results of the October soil sampling, and condition of the plants growing in the lysimeters, were:

Vegetation	Average inches depth of water stored in soil		Condition of vegetation cover	
	Large lysimeters	Unconfined lysimeters	Large lysimeters	Unconfined lysimeters
California buckwheat	5.6	6.6	Poor	Excellent
Chamise	6.6	5.8	Poor	Excellent
Hoaryleaf ceanothus	6.0	6.5	Poor	Excellent
California scrub oak	6.1	7.0	Good	Good
Coulter pine	7.3	7.4	Good	Good
Bare	14.2	--	--	--

Additional moisture samples were taken in October through the soil under each of the five unconfined lysimeters, extending down to fairly hard rock (decomposed granite). The wilting point and field capacity of these soils has not been determined, but the moisture varied from 3 to 7 percent at depths of 72 to 153 inches below the surface. Fine roots were found in many of the soil samples taken at depths below 72 inches. This is evidence that chaparral plants growing unconfined in "open" soil obtain water from depths greater than 6 feet, and indicates at least one reason why the vegetation in the tanks appear to be under greater moisture stress.

Disposition of Rainfall.- The first draft was prepared of a manuscript intended for publication as a USDA Technical Bulletin, titled "Disposition of Annual Rainfall in California Watersheds," by P. B. Rowe and E. A. Colman. This paper reports upon several years of intensive water-cycle and soils studies at the North Fork and Bass Lake experimental areas, and on the San Dimas Experimental Forest.

Physiology of Chaparral.- The physiological studies mentioned previously have progressed as follows:

1. Studies on seed germination have been primarily concerned with the effect of fire on the germination of chamise seed, although some preliminary studies on other species have been started. Field plots have been set up in cooperation with the Forest Service Los Angeles River Flood Control Project to determine the effect on the germination of chamise seed of (1) a complete burn, (2) a burn only in the duff, (3) removal of the brush by cutting, and (4) raking of the duff after removal of the brush by cutting.

2. Macro-mineral nutrient studies. One-year-old plants of Adenostoma fasciculatum, Rhus ovata, Eriogonum fasciculatum, Pinus coulteri, and Quercus dumosa were supplied by the Flood Control project, and sand culture experiments with them were started in the greenhouses at California Institute of Technology.

3. In cooperation with the Flood Control Project, Bouyoucos moisture-determining blocks were placed at four depths in 16 different locations in each of 2 road fills, a total of 64 blocks per fill. These are to measure the available moisture supply throughout the year and the effect of planted vegetation on this supply.

4. Field plantings were made on 2 road fills and on one critical natural slope in cooperation with the Flood Control Project, in order to study the effect of watering on survival of the plants.

Berkeley and Field Work Areas

Soil Stabilization in Burned Watersheds.- By request of the Regional Office, Gleason was assigned to assist in the sowing of two large burns, Wheeler Springs on the Los Padres, and Green River on the Cleveland. The sowing was done by the Region in cooperation with local agencies and the State Division of Forestry; 42,000 acres were sown with 150,000 pounds of mustard seed. Gleason also handled the research aspects of these jobs. In each burn a series of plots was installed to test further the adaptability of plants other than mustard for erosion control in burned areas. Each installation included the sowing of more than 20 species of grasses and forbs, including legumes.

At the request of the Regional Forester, these experiments were extended to include a pilot-scale study with a mixture of grass seeds. Several hundred acres on the Green River burn were sown by airplane; the species used were selected with the advice of the range group of the Experiment Station.

The Wheeler Springs fire swept over a part of the old Matilija burn, in which groups of iron erosion pins had been set in 1932. These pins were re-measured following the 1948 fire and before any rainfall had occurred, thus giving an opportunity to observe changes in soil levels during the past 16 years, and affording a base for measurements of any future changes resulting from the 1948 fire.

Burned areas on the Cleveland and Angeles National Forests, sown to mustard in 1947, were re-examined this year as part of the continuing observation of effectiveness of the sowing, and the comparative uniformity of seed distribution by airplane and helicopter.

New information on use of the helicopter, and the comparative costs of sowing mustard by airplane, helicopter, and ground crews are given in the revision of Research Note 37 by Gleason, issued in September.

Use of the helicopter for spraying Ribes in mountain areas was observed at the invitation of the Blister Rust Control Office (Bureau of Entomology and Plant Quarantine) and a report was prepared by Gleason and Fowells appraising the performance of this aircraft for possible application to other kinds of forest work.

Other Activities.- From late July through early September Colman was detailed to the Upper Missouri River Basin flood control survey to handle the soils aspects of the survey. In this work he was able to use an approach to wildland soil surveying described in the October 1948 Journal of Forestry, and to assemble in a relatively short time the pertinent data for a large area.

At Berkeley and on the San Dimas Experimental Forest, training in Forest Influences research extending through several weeks was given to foreign students Edmundo Ressini, of Bolivia, and Rodolfo Yussem, of Argentina.

Cooperative activities made heavy demands on the Division's time, but returned evidence of a broadening interest in the region's watershed problems. Requests ranged in subject matter from hydrologic data for specific watersheds to general talks on watershed management, and came from consulting engineers, school faculty and student groups, colleagues in Region 5, and legislative committees.

One good example of this broadening interest was a request to the Director from the State Forester asking for a plan for an examination of mountain watersheds as they affect California's water resources. Making such a survey was urged by the Conservation Association of Southern California as a necessary supplement to the new survey of the state's water resources started in 1948 by the State Division of Water Resources. The plan was prepared by Kraebel and Ilch and turned over to the State Forester.

An unusual field trip provides another example. With Littlefield, of the Regional Office, Kraebel accompanied the California Joint Legislative Committee on Water Problems on a tour of hearings and field examinations of water problems in the Sacramento Valley. This trip gave opportunity for discussions with the Committee Chairman, Senator Crittenden, and other committee members of the importance of proper watershed management in the state water picture.

Plans for 1949

1. Continue the operation of the San Dimas Experimental Forest and the analysis of data from the area.

2. Complete for publication the following manuscripts:

"Trees and Shrubs for Erosion Control in Southern California," by J. S. Horton.

"Rainfall Interception by Chaparral in California," by E. L. Hamilton and P. B. Rowe.

"Peak Discharge and Erosion Rates from Southern California Watersheds as Influenced by Fire," by P. B. Rowe, C. M. Countryman, and H. C. Storey.

"Disposition of Annual Rainfall in California Watersheds," by P. B. Rowe and E. A. Colman.

Revision of the R-5 "Guide for Sowing Mustard...." to incorporate information on use of the helicopter, and recent changes in procedure. (Planned for 1948 but deferred.)

3. Prepare manuscript reports on:

Development of vegetation cover following fire in the chamise chaparral of southern California. (J. S. Horton and C. J. Kraebel)

The relation of fire to germination of chamise seed. (E. C. Stone)

Rainfall interception by second-growth ponderosa pine in California. (P. B. Rowe and T. M. Hendrix)

The storm vector. (E. L. Hamilton)

4. Continue study of rainfall measurement on the San Dimas Experimental Forest to improve the accuracy and economy of the job of rainfall measurement in mountain areas.

5. Continue the physiological and ecological studies of chaparral in cooperation with the Los Angeles River Flood Control Project and California Institute of Technology.

6. Prepare plans for experimental treatment of one or more of the Bell small watersheds and start supplementary pre-treatment observations, including infiltration and soil-moisture measurements.

7. Continue cooperation in-Service and with other agencies on watershed problems.

FLOOD CONTROL SURVEYS
(D. M. Ilch, Chief of Division)

Objectives

The work of this Division is divided into three broad functions; namely, preliminary examinations, advance studies, and surveys. The objectives of each for 1948 were as follows:

Preliminary Examinations.- Field reconnaissance and preparation of examination report on the Cedar and Green Rivers of Washington and the Eel River in California.

Advance Studies.- Continue compilation and cataloguing of data on watersheds scheduled for future survey.

Prepare plans and procedures for quick reconnaissance of burned areas where flood threat is imminent.

Complete plans for reporting local and flash floods in or adjacent to national forests.

Continue compilation of reservoir statistics, including survey of basins and analysis of deposition rates as conditions warrant.

Complete survey work outline for Willamette River.

Assist Soil Conservation Service in the preparation of a survey work outline for the Russian River watershed.

Surveys.- Complete revision of reports for the Santa Maria, San Gabriel, and Santa Ana watersheds.

Complete surveys of Santa Clara, Ventura, and San Diego group of streams.

Assist Soil Conservation Service in surveys of the Salinas, Russian, Willow Creek, and Moses Coulee watersheds.

Initiate survey of Willamette River watershed.

Activities and Accomplishments

Preliminary Examinations

1. Plans to examine the Cedar and Green Rivers were postponed when the time and funds allotted to these projects were given over to the special survey of the Columbia River watershed during the flood of June 1948.

2. Tentative plans to examine and report formally on the coastal streams of Oregon and certain headwater streams of the Columbia also were postponed. Cataloguing of basic data and preparation of base maps continued preparatory to a survey of the watersheds.

3. Office work for the examination reports on the Eel and Mad Rivers continued in preparation for the field reconnaissance when weather conditions permit. Tentative arrangements have been made with the Regional Office for a field trip into the headwaters with representatives of the Corps of Engineers.

Advance Studies

1. Survey work outline for the Willamette watershed survey was completed and approved by both the Forest Service and Soil Conservation Service.

2. Assistance was given to the Soil Conservation Service in preparation of a survey work outline for the Russian River survey.

3. Assembly of reference material and data was continued for the Columbia River watersheds and streams in western Washington and Oregon.

4. Surveys on Mono and Agua Caliente debris basins were completed and the data analyzed. Sediment deposition data were collected and analyzed on several other reservoirs including Santiago in Orange County and several in San Diego County.

5. Reports and plans were prepared for emergency protection of the flood threat resulting from the Wheeler Springs and the Green River burns in Los Padres and Cleveland National Forests. A similar investigation was made of an extensive burn in Santa Cruz County.

6. Preliminary plans were prepared for an organized reporting and investigation of local and flash floods. One such flood was investigated and reported on in the Klamath watershed during the year.

7. The Division assisted in the field reconnaissance and preparation of the Special Flood Damage Report on the Columbia River Flood of June 1948.

Surveys

1. Wrightwood, on Sheep Creek, tributary to the Mojave River.- The interim survey report recommended a combination of debris dams, lined channels, and zoning of potential flood over-flow areas to protect existing improvements and to guard against unwise new developments in this recreational area. The flood source areas originate on national forest lands from extensive land slumps which, when saturated, cause destructive mud flows through the privately owned recreational developments in Wrightwood Village. Local interests are unwilling and unable to participate in the program to the extent recommended in order to provide the maximum degree of protection. Subsequent revision of the report provided an alternate plan of limited protection, which has been reviewed at the regional level by interested members of the Federal Inter-Agency River Basin Committee and State Review Committee, composed of representatives of the University of California College of Agriculture and the State Engineer's Office.

2. Santa Maria River (California) Survey Report.- Existing problem areas contributing to excessive run-off and erosion include the Cuyama River drainage and the hill lands encircling the Santa Maria Valley. The Sisquoc River drainage is a potentially high contributor should the watershed cover be depleted. The program in aid of flood control is aimed at reducing flood discharges and sedimentation by improving land management practices on the range and crop lands, and intensifying fire protection on the forest and brush areas. Supplemental engineering works are needed in certain local areas to assist in re-establishing a plant cover on severely eroded crop and pasture lands. Flood control benefits were estimated on the basis of infiltrometer tests. Water conservation rather than flood control is of greater concern locally, yet it is a benefit for which insufficient data are available for quantitative determination. The State Review Committee has inspected the watershed in the field and is now reviewing the report.

3. San Gabriel River (California) Survey Report.- This watershed presents two distinct problem areas. One is the steep unstable San Gabriel Mountains mass whose streams are partially controlled by an intensive system of reservoirs and debris basins near the foot of the mountains. Fire protection, improvement of the cover, and stabilization of critical source areas are considered the key needs in these mountains where erosion rates are normally high. Because of the generally severe physiographic conditions, stabilization cannot be accomplished easily or quickly. Therefore, this phase of the program has been set up for a relatively long period of time--approximately 80 years to complete installation. The other problem area is the valley and hill land in the lower half of the drainage where sedimentation and flood run-off continue to cause damage.

This report has been submitted to the State Review Committee for comment.

4. Santa Ana River (California) Survey Report.- This watershed, occupying portions of three southern California counties, has presented several conflicting problems in the course of developing a watershed treatment program. Water conservation and flood control vie for top billing in various parts of the drainage area. Each in its own way is obstructed to full accomplishment by the jealous guarding of water rights in each of the three counties. Measures considered for the headwater mountain areas must guard against impounding or retention of any surface flow which counties lower in the basin claim in part.

The program developed for this basin is similar to the one proposed for the adjoining San Gabriel drainage. Its principal flood control objective is to reduce flood water and sedimentation damages through intensified protection of steep mountain areas, improved land management practices on the crop and range lands, stabilization of active sediment source areas through revegetation and mechanical controls.

This report also has been submitted to the State Review Committee for comment.

5. Santa Clara-Ventura Rivers (California) Survey.- Report was completed in rough draft and will be submitted to the State Review

Committee early in 1949. Serious water shortages in this basin in recent years have focused almost all attention locally on water conservation. Consequently, local interests are currently directing their efforts almost exclusively to the improvement of their water supplies. Enthusiastic consideration is given to any plan incorporating major water storage structures or improvements to increase rate of ground water recharge. One of the key measures considered in the program for this watershed will be intensified fire protection, which may meet with some objection by certain local interests who have indicated that continued protection of the mountain area has intensified the fire threat.

6. San Diego County (California) Group of Streams.- Field work was completed and a first draft of the report prepared for review by the Soil Conservation Service and the State Review Committee early in 1949. Problems similar to those encountered on the Santa Clara-Ventura watersheds were again present on this survey. The relative infrequency of floods and flood damage has emphasized the local need of water conservation.

7. Willamette River (Oregon) Survey.- The survey was started in July 1948 under none too favorable conditions. Basic investigations on the influence of natural cover and land-use on stream flow and erosion are completely lacking for Westside Cascade areas. Further, the current flood-control program of the Corps of Engineers will provide about 85 percent protection to most of the known damage areas. In this region of relatively high annual precipitation and dense natural cover sedimentation did not appear to be a serious threat to existing and proposed reservoirs of the Army if the evidence of the few sedimentation surveys in the watershed were to be relied upon as indicators.

Therefore, the initial job of the survey appeared to be one of analyzing and interpreting the mass of hydrologic data in relation to land-use to attempt determination of causative factors connected with observed flood occurrences. Multiple regression analysis is being used to evaluate those factors affecting flood magnitude and to attempt to determine the extent to which watershed management practices may affect run-off. Some of the factors being analyzed are: (1) Storm precipitation, daily maximum precipitation, and accumulated prior precipitation; (2) snow depths, densities, and soil freezing; (3) watershed cover and use conditions at time of flood.

Initial work on damage appraisals has been confined to determination of the extent and coverage of inventories prepared by the Corps of Engineers. During the current winter season numerous field examinations were made of those tributaries on which no downstream controls are proposed.

A reconnaissance has been made of the watershed to locate areas of stream sedimentation, deposition areas, stream bank cutting, and stream scour.

8. Walla Walla River (Washington) Survey Report, under the direction of the Soil Conservation Service, was reviewed after further revision.

9. Salinas River (California) Survey..- Assistance was given to the Soil Conservation Service in the preparation of the wildland phase of the program which was completed on schedule.

10. Russian River (California) Survey was begun by the Soil Conservation Service in July and scheduled for completion by June 30, 1949. Assistance was provided in the preparation of the wildland phase of the program.

11. Willow Creek (Washington) Survey, under direction of the Soil Conservation Service, required assistance from the Division only to the extent of developing a limited program of wildland management on the small forested area in the watershed.

Miscellaneous

1. The Division was represented at a number of subcommittee meetings of the Columbia Basin Inter-Agency Committee relative to hydrology, costs, and benefits.

2. The Division participated in the regional meetings of the Federal Inter-Agency River Basin Committee to establish hydrometeorological requirements on Pacific slope drainage basins.

3. Two manuscripts were completed and submitted for publication under the following titles: "Flood Frequencies and Sedimentation from Forest Watersheds" by H. W. Anderson and "Influence of Some Watersheds on a Major Flood" by H. W. Anderson and H. K. Trobitz.

Plans for 1949

1. Preliminary Examinations

   a. Complete report on Eel-Mad Rivers in California.

   b. Complete reconnaissance and report on Klamath River.

   c. Assist the Soil Conservation Service in preliminary examinations of the San Francisco Bay watersheds and the central California coastal watersheds not yet examined.

2. Advance Studies

   a. Complete survey work outlines for Sacramento-San Joaquin group of streams.

   b. Complete survey work outline for Columbia River watersheds.

   c. Continue maintenance of data and reference files on watersheds scheduled for investigation and survey.

   d. Assist in preparation of survey work outlines for watersheds to be investigated under Soil Conservation Service direction.

3. Surveys

a. Complete field processing of reports on Santa Ana, San Gabriel, Santa Maria, Santa Clara, Ventura, and San Diego group of streams by discussing programs with local interests and submitting reports for review by the regional offices of the Federal Inter-Agency River Basin Committee members.

b. Continue survey of Willamette River watershed, complete initial investigations, and begin program development stage.

c. Begin new survey of either Columbia River watersheds or Sacramento-San Joaquin streams, depending upon availability of funds for the fiscal year 1950.

d. Assist the Soil Conservation Service in surveys of Russian River in California and other watersheds as requested.

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